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HAVE PLANTS A PEDIGREE?

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WE have lately been reminded, by a writer in the *North American Review*, that the builders are the metaphysicians, and that science is only a brick-yard. How many, then, would quit the service? No! wiser we think were the words of the late Cambridge professor: "We have reached the point where the results of science touch the very problem of existence, and all thoughtful men are listening for the verdict which solves the great mystery." There is a great truth here which people are beginning to recognize, and there can be little doubt that the strongest hold which Science now has upon the public mind, comes from the light she is supposed to be able to throw on "the problem of existence." The vegetable kingdom has many aspects of interest, but Science has now raised the profound inquiry how it came to be—that is, the problem of its existence. We propose to set forth in this paper part of the testimony which plants give on the question of their origin.

In the floral world that which first catches the attention is color, and, although in classification it passes for almost nothing, no other property or quality affects the mind so deeply. The great poets, who are always wiser than they know, have literally *painted* the vices and virtues. Anger is *scarlet*—

> "The ashy paleness of my cheek
> Is *scarleted* in ruddy flakes of wrath."

Jealousy is *yellow;* modesty is *crimson;* melancholy is *blue;* cheerfulness, hopefulness, youth, are *green;* malice, vengefulness, falsehood, are *black*, and truth and purity have never been painted to the imagination more simply and beautifully than by Shakespeare in this:

> "White-robed truth;"

and by Milton in this:

> "The saintliest veil
> Of maiden-white."

May not color be of more importance in botany than the system-makers have supposed? How did flowers come by their colors?

If two colors are placed in juxtaposition, to produce the most pleasing effect they should be complementary, as red and green, orange and blue, yellow and purple. What, now, is Nature's method among her flowers?

He who has seen the calypso will remember it as the rarest of color-gems. The petals are of brilliant purple, the lip, deep within of gorgeous yellow, shades off into purple inoculated with darker purple. This floral gem is painted in two colors complementary to each other.

From calypso, which is rare, you pass to a flower of the same family which is not uncommon, the showy lady's-slipper (*Cypripedium spectabile*). In this we have three colors. The petals are snow-white, the lip is lustrous white melting into magenta, which in turn deepens into purple, and the sterile stamen, which mimics a petal and dips into the sac formed by the inflated lip, is pale yellow. The white of our lady's-slipper is the purple and yellow *blended* together; and we shall find, in general, that when a flower has three colors, two of which are complementary, the third will be *white*, representing the blending of the other two.

The wild-asters, like the calypso, are of two colors, the color of the ray being, in general, complementary to that of the disk, and thus the most common of our autumnal flowers are pleasing to the eye. The rose and English hawthorn are of one color, which harmonizes with the foliage, as red is the complement of green. But Nature has another side.

The corolla of the closed gentian, which is set in a green calyx, is deep blue. Here is chromatic discord.[1] The "lilac"-colored flowers of the lilac, in contrast with the green leaves, form another discord. No lady would think of dressing in lilac and green.

Our buttercups and golden-rods are yellow. In the golden-rod neither the yellow of the flower nor the green of the foliage is strongly marked, and the contrast is not displeasing. But the bright yellow of the buttercup against the fresh green of the leaves and the spring grass makes a chromatic discord. Green and yellow are not in accord, and Shakespeare, taking green for youth and yellow for jealousy, uses this color-discord with fine effect:

> "She never told her love,
> But let concealment, like a worm i' the bud,
> Feed on her damask cheek; she pined in thought,
> And with a *green and yellow* melancholy,
> She sat like patience on a monument,
> Smiling at grief."

[1] Green and blue—green tends to give its complementary, red, to the blue, which renders it more violet; blue tends to give its complementary, orange, to green, which renders it more yellow.

Traveling on a June day from Bangor to Boston, we observed all the meadows and waste fields through the shale region of Central Maine overrun with bulbous crowfoot — the *Ranunculus bulbosus.* The face of the earth over large patches was literally green and yellow, and the chromatic effect began to tell very unpleasantly on the eye. Passing from the shale into a region of granite we found the buttercups giving place to the white-weed (*Leucanthemum vulgare*). Over the pastures of Massachusetts this was as common as the buttercup in Maine, and the face of the earth was now *white* and green. The relief was felt at once. It was now a pleasure to look on the meadows. And yet the pleasure would have been still greater if the leaves and grass had been light blue instead of green, as white and light blue are in still better accord than white and green. But we will not be over-critical. A lady in white can wear a scarf, or sash, or breast-knot, of any color she may wish; and Nature, if she decks herself in white flowers, may set them in green, or brown, or red, or any tint she will, and there will be no discord.

The discords we have considered are between the flower and the foliage. There are others in the flower itself.

In the sweet-pea we have red and violet, a juxtaposition as discordant as that of green and blue. The bird-foot violet has the two upper petals of deep violet, the others of lilac-purple or blue—another discord. And such a collocation produces not merely a chromatic discord. Rays of blue and violet, entering the eye together, cause fluorescence of the cornea and crystalline lens. These parts become faintly luminous by the absorption of such light, and vision is rendered imperfect.

All this may seem fanciful. A field of green and yellow may appear to most eyes as pleasing as one of green and white. A violet, colored in violet and blue, may be called as beautiful as a calypso, in yellow and purple. But eyes which cannot see chromatic discord cannot see chromatic harmony. If a bad picture does not offend the taste, a good one cannot gratify it. There lies on our table a magazine printed in colored inks, an effort, the publisher tells us, to supplant the old monotony of black and white, and to minister to our love of color. It has a *yellow* cover bordered with *scarlet* and labeled in *green!* Flowers may not be guilty of chromatic offenses so atrocious as this, but such offenses they certainly do commit.

What is the end of floral decoration? By the old way of interpreting Nature, the botanist would have said, "To gratify man's love of the beautiful." He would not give such an answer now. If he would explain why certain flowers are not colored at all, and how it has come about that other flowers are colored, some in chromatic harmony, and others not, he must look to the flowers themselves, and to their servants the insects. Every one knows that the pollen must find its way from the anther to the stigma, else the flower, lacking impreg-

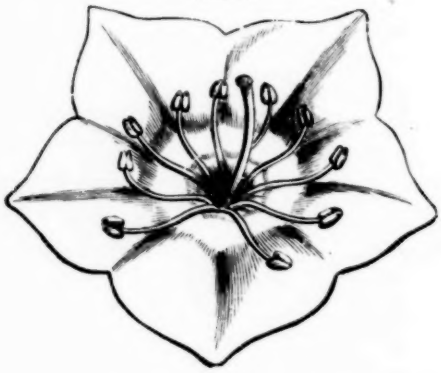
nation, can set no seed. For many trees, and for grasses generally, the office of transporting the pollen is performed by the wind. And, "as the wind bloweth where it listeth," it may waste a million pollen-grains for every one it lodges on a stigma. Hence the prodigality of pollen. If you walk through a field of corn, you will note how generously the tassel yields its pollen to the wind. If, toward the last of May, you shake a branch of pine, you will see floating from it a cloud of pollen-grains.

Having seen the largest prodigality, we will search now for the closest economy.

In many of the violets we find, in addition to the showy flowers, another set borne on runners and concealed under leaves. In the fringed polygala we have another case of dimorphism. In one flower the petals are of richest pink, two of them spreading out like wings, and the other, keel-shaped, crested and fringed. Another flower, which never opens, is borne close to the ground, or even in the ground, on subterranean shoots. Now, these ground flowers of the violet and polygala are self-fertilizing. One grain of pollen is enough for one seed, and that is all which Nature, in these flowers, will furnish.

You will observe now that the pine and the corn, in general all conifers and grasses depending for fertilization on the wind, have colorless flowers and much pollen, and that concealed flowers are without color and have but little pollen. We begin to suspect that color stands in some relation to the needs of the flower. In the grasses and pines it would be of no use, as the wind will find a dull flower as easily as a gaudy one. In self-fertilizing flowers it is also of no use.

FIG. 1.

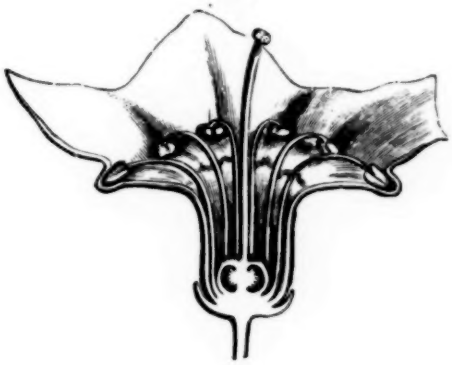


Eighty years ago Sprengel maintained that breeding in and in would be as injurious in the vegetal as in the animal world, and he argued that colors and odors attract insects and thus secure cross-fertilization. It was the largest thought which had ever entered the head of a botanist. But Sprengel was ridiculed in his own generation and

forgotten in the next. Thirty years ago Charles Darwin discovered the German's idea in an old, castaway volume, and at once he began to employ his matchless powers of observation in questioning Nature for its truth. He has taught us how to use our eyes. Let us look.

One of our most beautiful shrubs is the mountain-laurel (*Kalmia latifolia*). It blossoms all over in corymbs of bell-shaped flowers, white, tinged with red, having short nectaries and recurved stamens, whose anthers are inserted in little pits of the corolla. In Fig. 1 the flower is shown with the anthers out of their sockets. In Fig. 2 we have a section of the flower showing the recurved stamens and the anthers resting in their pouches. It will be seen that the stamens are shorter than the style. How is the anther to be liberated from the pouch? And how is the pollen to be carried to the stigma?

FIG. 2.

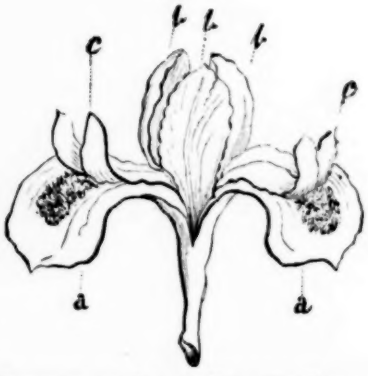


The kalmia is one of the most showy shrubs along the wooded waysides of New England, and is very attractive to bumble-bees. Now, your bumble-bee is the clumsiest of insect. His action is as ungraceful as his person. He can do nothing expertly and neatly. He cannot even sting you while on the wing, but must first alight and adjust himself. At nectar-getting he is as clumsy as at stinging. He *sprawls* over a flower, pushes here and there among the delicate organs, and gets himself thoroughly bedaubed with pollen. This clumsiness makes him a good marriage-priest for the flowers. The color of the laurel attracts him, and the nectary promises honey. He lights, gets his legs entangled among the stamens, and as he jostles them they spring from their little pits with a sharp snap and scatter their pollen over his back. In visiting another flower some of the pollen will find its way to the stigma and thus secure cross-fertilization.

The iris would seem, at first thought, to have been specially planned for *self*-fertilization. As will be seen in Fig. 3, the petaloid stigma covers the petaloid stamen. But a most curious fact is that, while the stigmatic surface is brought right up against the stamen, the

anther is turned outward away from the stigma. This arrangement will be seen in Fig. 4, which presents a longitudinal section of the flower after the petals have been removed. It is as if you apply powder to the surface of one sheet of paper and mucus to the surface of another, and, intending that the powder should be brought into contact with the mucus, place the two sheets together, surface to surface,

Fig. 3.



Flower of an Iris, or Flower-de-Luce: *a*, *a*, two of the three outer petals; *b b b*, the three inner petals; *c c*, two of the branches of the petal-like style.

Fig. 4.

A Longitudinal Section of Fig. 4: two branches of the style being cut through, show the plate-like stigmas *a a*, which loop the anthers *b b*.

but turn the *powdered* surface out. What a seeming design, and yet, seemingly, what a fatal blunder! But this is nature as manifested in the iris. Pollen and stigma, so close together, are separated by the blade of the stamen. But for insects which, attracted by the color, light, and search the flower for its nectar, and push, now against an anther and now against a stigma, the iris could never set a seed.

Flowers, as Dr. Gray has said, seem to be made on the principle, "how not to do it." By traps, and pits, and springs, insects are made to do by indirection what it would seem could be better done directly by the flower itself. For many flowers the service can be rendered as well by one nectar-loving insect as another. But in some species the parts are so modified that only a single species of insect, correspondingly modified, can reach the organs of fructification. In the northern part of the United States the yucca (Fig. 5) has never been known to set seeds.

An entomologist has lately discovered a small moth with white head and thorax and wings, and legs of dingy yellow. To this moth he has given the name *Pronuba yuccasella*—yucca's go between. The structure of this moth will be seen in Fig. 6. In Fig. 7 the larva and the moth are drawn in the natural size. The peculiarity of this moth is, that in the female the basal joint of one of the maxillary palpi (Fig. 6, 5) is modified in a most wonderful manner into a long prehensile

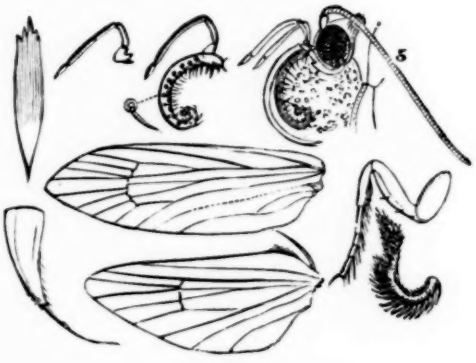
tentacle. With this she collects the pollen and thrusts it into the stigmatic tube against the stigma. In this pollen-mass she lays her eggs. A single palpus of the female of a single species of moth, modified in a peculiar way, is the means of perpetuating the yucca. In its native home yucca and yuccasella are inseparable. In the north, yuccasella does not thrive and yucca can set no seeds.

FIG. 5.

Well, if plants depend so much on insects, insects must have some way of knowing where they are. As an optical instrument, the eye of an insect is rather imperfect, but it is not color-blind. A butterfly may not be sensitive to the harmonies of color, but it certainly knows

a colored object from an object not colored. We need more observations before we can safely say that insects apprehend the different shades of color, and prefer one shade to another; but, if any one will watch bees on a bed of hyacinths, he will see that a particular bee is apt to confine itself to a particular color.

FIG. 6.

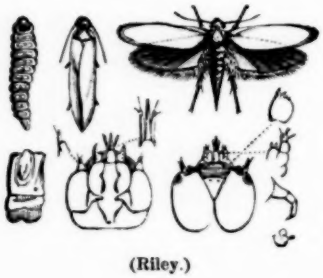


(Riley.)

We conclude that color and nectary are in correlation with the organs of fructification and with the eyes and appetites of insects.

Odor must come under the same law as color. We must seek for its *rationale* in the flower itself and the forces or agents which act on it. The hidden flowers of violet and polygala are odorless as well as

FIG. 7.



(Riley.)

colorless. The grasses, pines, and palms, whose pollen is borne on the wind, are inconspicuous in color and are generally without odor. But some species of palm require the visitation of insects, and while their flowers remain inconspicuous in color they are rich in perfume. The fan-palm of the Rio Negro perfumes the air far and near with the odor of mignonette. Myriads of insects, attracted by the fragrance, hum and buzz among the flowers, and carry pollen from the staminate to the pistillate ones. This odor is pleasant to man as well as insects.

But there are floral odors as well as colors which are offensive. We do not understand the laws of odor so well as those of sound and color. We educate the eye and the ear, but in the nose we are still cave-men. If we can trust a *savant* who has spent years in the cultivation of his olfactories, odors are under the same law as sounds and colors. Certain odors blend into a sort of music of smells as certain notes into a music of sounds. Other odors refuse to blend, but jar on the nose like discordant sounds on the ear. Septimius Piesse must live in a world of harsh notes and grating discords. Even to us the account seems nearly balanced between the odorous and the mal-odorous. The wild-rose is sweet, but the datura is sickening. The ailantus may be scored against the pink, and against the jasmine, the queen of flowers, whose fragrance is the only secret the floral world withholds from our chemistries—against the jasmine may be scored the carrion-flower. The odor of the flower is what its name implies. Surely it was not given for man's pleasure. Then for what? Perhaps from this very flower we may learn the *rationale* of odors.

The flower of the carrion-plant is of a pale yellow-green and is altogether inconspicuous. If it had no attraction but its color, it would never win the attention of an insect. Now, it is a fact of great significance that this carrion-flower is fertilized by the blow-fly. But what does the blow-fly want of a flower? If this flower were sensitive and rational and skilled in chemistries, we might imagine the correlation between itself and the fly to be the result of a mental process something like this: "At any cost I must secure fertilization. The wind cannot serve me, and bees and butterflies cannot find me. I will invite the blow-fly—I will practise deception. I will smell like decaying flesh!" Of course, this is fanciful. Suppose we imagine an intelligence *outside* of the plant, and the insect arranging by special creation such correlations between color, odor, nectary, and bees, moths, flies, and butterflies. Does it bring us any nearer to a mental resting-place? Rather, do not questions without end start up in the mind? Why such indirection? Why such seeming design marred by seeming chance as in the iris? And if all these structures and colors and odors are the result of special creation, what shall we say of deadly nightshades? of poison-ivies? of the fungi which live on the human body? Was there a special provision for certain fungi to grow on the forehead? for others to thrive in the mouth? for others still to infest the stomach? Was the body of man designed to be the habitat of pain-giving parasites? We have found plants good and not good, beautiful and not beautiful, odorous and mal-odorous. If the world were a theophany, would it not be good only, good everywhere and equally? To interpret the vegetal world as a "special creation" no more satisfies the religious sentiment than the reason.

Our common loosestrife (*Lysimachia quadrifolia*) is one of the most variable of species. Its European representative (*L. vulgaris*)

appears in two well-marked varieties: one, found in sunny localities, whose petals are dark yellow, with red at the base; and the other, growing by shaded ditches, with petals of light yellow, and no red at the base. The more conspicuous variety attracts insects, and, as the stigma overtops the stamens, the agency of insects is required to secure fertilization. The flowers of the less conspicuous variety are not visited by insects, and, as the stigma does not overtop the stamens, the agency of insects is not required. The flower is self-fertilizing. These two forms graduate into each other, by connecting links which are found on the *sunny* edges of ditches.

Here is a very instructive lesson. Greater amounts of sunlight will account for the richer color of one variety; and the agency of insects, attracted by the color, will account for the change in structure. We see Nature in the act of species-making. Insects, acting mechanically on the delicate organs of a plant, effect something more than fertilization. Let us consider this action more carefully.

Dr. Ogle has observed the manners of the bee in visiting beans and scarlet-runners. These flowers are arranged to secure cross-fertilization. The honey they offer must be taken by an insect which will enter by the open door of the corolla-tube. But Dr. Ogle observed that while certain bees visit the flower in the legitimate way, and thus carry pollen from anther to stigma, others have a trick of evading their duty by piercing a hole in the calyx-tube, thus securing the nectar by a short cut. An important fact noted in these observations is, that the same bee always visits a flower in the same way. The inference is, that this habit of nipping the calyx is the result of individual experience. As some bees have acquired the habit, and others have not, another inference is that these insects are intelligent, and that they differ from each other in *degrees* of intelligence. Our final inference is that, if all bees are ever schooled up to this new art, there must come an end to our beans and scarlet-runners—unless some modification should occur in the structure of their flowers.

The salvia is constructed as if with special reference to fertilization by bumble-bees. But Mr. Meehan, who first pointed out the correlation, never saw a bumble-bee enter the flower. Under his eye the bee always cut the tube of the corolla. But another observer *has seen* the bumble-bee enter the flower and effect fertilization. And he has seen it nipping the corolla-tube to secure the honey by a short cut. *And he has noticed that the smaller bees entered the corolla-tube, and that those which were too large to get into the flower nipped the tube.* This is an important observation, and brings us to the very heart of the matter. The salvia with small corolla-tube, not securing fertilization, stands but little chance of surviving. The flower with large tube invites the bee, is fertilized, and ripens seed. "Natural selection" is going on under our very eyes. Now, if, in "the struggle for existence," a larger race of bumble-bees should appear, the salvia must either vary with

the varying insect, or die out. And we have no right to assume that the *body* of an insect is a fixed bulk or structure any more than that the "instinct" or intelligence is fixed and invariable. Prof. Riley has shown the extreme probability that the peculiar modification of the palpus of the female yuccasella, which makes her the marriage-priestess of the yucca, was brought about little by little, as the peculiar structure of the flower came little by little. Flowers *must* vary with insects, and insects with flowers—yucca with yuccasella, and yuccasella with yucca—or both must die.

We have now the *rationale* of colors and odors. As vitality seems to have some general relation to color, perhaps the first show of color in a floral envelope was due to a slight diminution of vital force.[1] Color being advantageous to the plant by attracting insects, when once it appeared its shades would be multiplied and intensified age after age, by natural selection. And as color is developed little by little as the result of insect-vision, modifications of structure are developed, in equal pace, by insect-touch.[2]

This is not all. An organism is modified by all which environs it. Mr. Spencer, in his great work on "Biology," has shown us that the form of the cell, the leaf, the branch, the trunk, the flower, is determined in great part by the environment. Varying amounts of sunshine or shade modify the form of a branch. A prevailing wind modifies the form of a tree. A change of position on the stem changes the form of a flower. The drooping gloxinia in your conservatory is *bi-symmetrical*, and has a rudimental fifth stamen. Culture brings the flower up, erect on the stem, makes it *radically* symmetrical, restores the rudiment to a perfect stamen, prunes the flower of its eccentricities, and makes it *regular*—just as it does with a man.

Nature is, in the plant, what her name implies, "*natura*," a something about to be, a continual becoming. We see what changes are going on in the garden. Changes the same in kind are going on in the fields and the woods. A stroll over Goat Island on any May day will show the observant eye how variable in size and color and even in structure is the *Trillium grandiflorum*. The white-weed which overruns our Eastern meadows has sported into a score of incipient varie-

[1] White is excess of color, and every florist knows that a plant with white flowers has pale leaves and stem, as if the entire plant were in sympathy with the petals, and were lacking in vitality.

[2] A recent writer has said that, if chance were the ruler of the world, it would not be the *highest* ruler, as the law of chances is higher than chance itself. If the coloring of flowers, he would say, were even a thing of chance, still, by this law, the blending of colors and their juxtaposition, in the main, would show some kind of order. But we can account for the prevalence of pleasing colors and odors without falling back on the law of chances. Very low down in organic Nature is the sense of beauty. A bright color is bright to the eye of a bee as well as to our own. In the course of time those odors and that display of color most pleasing to the senses would, by natural selection, become prevalent and hereditary.

ties, and, although but a new-comer on our shores, already in Connecticut it appears in a variety fixed and well marked. Incipient doubling is not uncommon, and now and then may be found a thalictrum or a saxifrage full-double. From the wild-strawberry (*Fragaria Virginiana*) has diverged a well-marked variety called the *F. Illinoensis*. From this has diverged still another variety found by Mr. Gillman in great abundance on the shores of Lake Superior, far away from the influence of the gardener—a variety of a variety.

And now, as the visitation of insects, as more or less light, more or less heat, more or less wind, more or less room, more or less soil, are known to effect changes in the color, size, form, and even structure

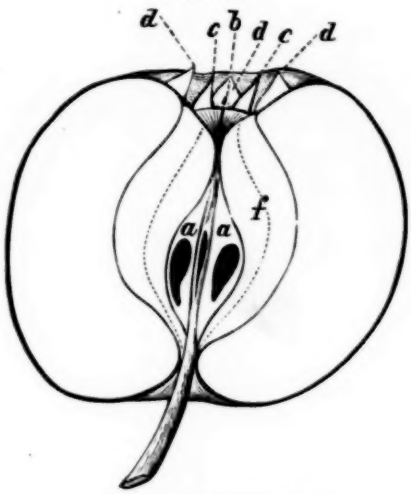
FIG. 8.

WATER-LILY—(*Nymphæa odorata*).

of plants, if the vegetal world has come to be what it is through the action of these secondary causes, we should find reminiscences of a primitive, undifferentiated type.

Theoretically the plant is a leaf. The axis or stem is a fused series of midribs. The floral organs are leaves variously modified. Nay, we may look even beyond the leaf to the components of the leaf, for thought cannot rest till it finds the ultimate unit. This is a cell, and the lowest plant is *simply* a cell. Cells adherent to cells form a frond. A frond, by a little modification, passes into a leaf, and a leaf into a part of the flower. A sepal is a leaf changed but little; a petal is a leaf changed in color and texture; a stamen is a leaf changed in color, texture, and form, the blade being eliminated except at the tip where it forms the anther, and the midrib remaining as a supporting filament; the pistil is a leaf with the lower part of the blade rolled up, and the edges united to form a carpel, and the midrib prolonged into a style, bearing atop a little shred of altered leaf-blade called a stigma. And here—at the very tips of these inner leaves where the nutriment is least and the vital force weakest—the investing membrane disappears; Nature slips back toward her simplest types, and shows us the naked primordial cells as pollen-grains! In the thistle one may see that the stem is continuous with the midrib of the leaf. Every observer knows that in the pond-lily (Fig. 8) we see the intermediate stages between a simple leaf and a pistil. And every one whose garden furnishes a syringa or double-flowering cherry, has only to look at the flowers to see pistils and stamens reverting to leaves.

FIG. 9



SECTION OF AN APPLE.
a a, carpels; *b*, remnant of pistils; *c c*, remnants of corolla; *d d*, remnants of calyx; *f*, fibrous line.

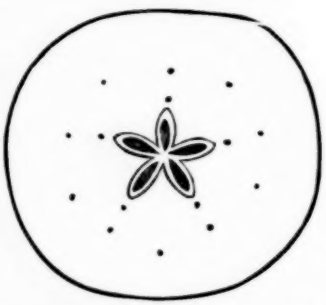
Fortunately for science, there grows in Kittanning, Pennsylvania, an apple-tree, which, in its flower and fruit, exemplifies the theory of the plant. Theoretically, a fruit is a branch with its leaves transformed.

If the reader will take an apple—a rotten one is best—and cut it through from flower-scar to stem, he will find a core of five carpels, and about midway between the core and the rind he will see a green, fibrous line (Fig. 9). If he will look now at the flower, he will find the cup or calyx of five sepals, the corolla of five petals, the stamens many (a number of whorls), and the pistils five (one whorl). We have shown that these floral organs are simply transformed leaves, and we shall now see that the apple itself is merely these leaf-whorls still further transformed.

Let us cut the apple through around the equator and compare our section (Fig. 10) with the longitudinal one (Fig. 9). Looking at the flower-scar, we see the remnants of the sepals, *d*, *d*, *d*. Within and alternating with these are remnants of the petals, *c*, *c*. Still farther within is a little shred of a pistil, *b*. This shred can be traced down into the core, *a*. The other parts of the flower lose themselves in the fleshy fruit.

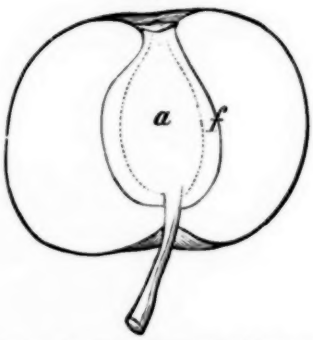
If we look now at the other section (Fig. 10), we shall see, on that fibrous line, ten greenish points, five opposite to the carpels and five alternating with them. Five other little points appear near the tips of the carpels and in line with them. Now, this fibrous line, and the points on it and within it, must bear some relation to the plan of the flower. And, as the stamens are a multiple of five, the points must have some relation to the staminate whorls. The core, as we see (Fig. 9), is continuous with the pistil. It is simply the base of the

FIG. 10.



CROSS-SECTION OF APPLE, SHOWING THE CARPELS AND FIBROUS POINTS.

FIG. 11.



SECTION OF THE KITTANNING APPLE. *a*, cavity which takes the place of the carpels; *f*, fibrous line.

pistillate whorl. The part of the fruit between the core and the dotted line represents the thickened and coalesced whorls of stamens and petals.[1] The fruit between this dotted line and the fibrous line represents the thickened petals. The fibrous line represents the union of

[1] This line is not found in the fruit. It is ideal.

the coroline with the calycine leaves, and the fruit between this line and the rind represents the calycine leaves, grown thick and succulent.

Now, the flower of this Kittanning tree appears as a mere rudiment. How, if this theory is true, should the *fruit* appear? The pistillate whorl is wanting, and in theory the apple should have no core. It has none, but in its place a large cavity, as shown in Fig. 11. The stamens are rudimental, and the petals are represented by five little bud-scales. Theoretically, then, we should find but little fruit between the core-cavity and the fibrous line. There is but little, as the cut will show. The calyx is better developed, and we should find more fruit between the fibrous line and the rind—as we do. The flower starts with all the essential organs of a flower, and, before the inner whorls are arrested, enough vitality is given to the outer whorl to start it on the way toward an apple. And with the lack of development in the inner whorls the outer one develops cork cells, and the rind takes on the character of bark!

This is Nature teaching by what is abnormal. Let us scrutinize her where she seems most regular and orderly.

The acorn, like the apple, is seen by everybody and known by scarcely anybody. We will take a full-grown acorn in its cup and cut it through about midway from top to base. We shall find five little roundish bodies pressed up close against the shell. What are they? and how came they here? We consult the flower, and find (in the fertile one) a style with a three-lobed stigma. The pistil, then, represents three transformed and infolded leaves. When the flower is a little more advanced, we will cut through the lower part of the pistil and examine a section. This part becomes the ovary, and we find in our section three partition-walls radiating from the circumference to the centre and dividing the ovary into three compartments. In this tripartite structure we find our three leaves, the infolded blades cohering along parts of their surface and forming the partition-walls. On each of these partitions we see two ovules. The ovules represent leaves budding out on the margin of the pistil-leaf, and thus every ovary, in theory, should have at the very least as many ovules as there are leaves composing it. In the flower we have now the plan of the acorn. The surface of the ovary will become a shell. The six ovules will grow and ripen into six seeds. Cutting through the shell of the full-grown acorn we shall find it to contain three chambers, and each chamber two naked acorns. We find nothing of the sort! Where was the slip? Early in the acorn's life one of the six ovules gets the start of its neighbors and takes to itself all the nutriment. It grows too large for its chamber, and breaks the partition-walls. It grows to the measure of all the chambers, fills them, and pushes its shriveled brethren up against the shell-wall where you see them, five little starved-out things which once were possible oaks! Strange, is it not? And how passing strange if the oak were made so by "special creation!"

What perplexity does the thought, coupled with the facts, bring into the mind! But if these aborted ovules are reminiscences of an earlier age, and an acorn less differentiated from the general type of the ovary, the oak becomes intelligible. And in this light of evolution all aborted organs, all rudimental organs, all floral eccentricities, become intelligible. Botany itself ceases to be a toy, and commands the attention of such imperial minds as those of Spencer and Mill. Her boundaries are enlarged. The plant does not stand apart, the result of a single antecedent. It represents the action of countless forces through countless ages. It almost justifies Tennyson's apostrophe:

"Flower in the crannied wall,
I pluck you out of the crannies—
Hold you here, root and all, in my hand,
Little flower—but if I could understand
What you are, root and all, and all in all,
I should know what God and man is."

PUNISHING A SENIOR WRANGLER.

By HERBERT SPENCER.

IN the *British Quarterly Review* for January, 1874, the writer of the article to which I formerly replied,[1] makes a rejoinder. It is of the kind which might have been anticipated. There are men to whom the discovery that they have done injustice is painful. After proof of having wrongly ascribed to another such a nonsensical belief as that insensible motion is heat because heat is insensible motion, some would express regret. Not so my reviewer. Having by forced interpretations debited me with an absurdity, he makes no apology; but, with an air implying that he had all along done this, he attacks the allegation I had really made—an allegation which is at least so far from an absurdity, that he describes it only as not justified by "the present state of science." And here, having incidentally referred to this point, I may as well, before proceeding, deal with his substituted charge at the same time that I further exemplify his method. Probably, most of those who see the *British Quarterly* will be favorably impressed by the confidence of his assertion; but those who compare my statement with his travesty of it, and who compare both with some authoritative exposition, will be otherwise impressed. To his statement that I conclude "that friction must ultimately transform *all* [the italics are his] the energy of a sound into heat," I reply that it is glaringly untrue: I have named friction as a second cause. And when he poohpoohs the effect of compression because it is "merely momentary," is

[1] *See* POPULAR SCIENCE MONTHLY for March, 1874.

he aware of the meaning of his words? Will he deny that, from first to last, during the interval of condensation, heat is being generated? Will he deny to the air the power of radiating such heat? He will not venture to do so. Take, then, the interval of condensation as one-thousandth of a second. I ask him to inform those whom he professes to instruct, what is the probable number of heat-waves which have escaped in this interval. Must they not be numbered by thousands of millions? In fact, by his "merely momentary," he actually assumes that what is momentary in relation to our time-measures is momentary in relation to the escape of ethereal undulations!

Let me now proceed more systematically, and examine his rejoinder point by point. It sets out thus:

"In the notice of Mr. Spencer's works that appeared in the last number of this *Review*, we had occasion to point out that he held mistaken notions of the most fundamental generalizations of dynamics; that he had shown an ignorance of the nature of proof in his treatment of the Newtonian Law; that he had used phrases such as the Persistence of Force in various and inconsistent significations; and more especially that he had put forth proofs logically faulty in his endeavor to demonstrate certain physical propositions by *a priori* methods, and to show that such proofs must exist. To this article Mr. Spencer has replied in the December number of the *Fortnightly Review*. His reply leaves every one of the above positions unassailed."

In my "Replies to Criticisms," which, as it was, trespassed unduly on the pages of the *Fortnightly Review*, I singled out, from his allegations which touched me personally, one that might be briefly dealt with as an example; and I stated that, passing over other personal questions, as not interesting to the general reader, I should devote the small space available to an impersonal one. Notwithstanding this, the reviewer, in the foregoing paragraph, enumerates his chief positions; asserts that I have not assailed any of them (which is untrue); and then leads his readers to the belief that I have not assailed them because they are unassailable.

Leaving this misbelief to be dealt with presently, I continue my comments on his rejoinder. After referring to the passage I have quoted from Prof. Tait's statement about physical axioms, and after indicating the nature of my criticism, the reviewer says:

"Had Mr. Spencer, however, read the sentence that follows it, we doubt whether we should have heard aught of this quotation. It is: 'Without further remark we shall give Newton's Three Laws; it being remembered that, as the properties of matter might have been such as to render a totally different set of laws axiomatic, *these laws must be considered as resting on convictions drawn from observation and experiment, and not on intuitive perception.*' This not only shows that the term 'axiomatic' is used in the previous sentence in a sense that does not exclude an inductive origin, but it leaves us indebted to Mr. Spencer for the discovery of the clearest and most authoritative expression of disapproval of his views respecting the nature of the Laws of Motion."

Let us analyze this "authoritative expression." It contains several startling implications, the disclosure of which the reader will find not uninteresting. Consider, first, what is implied by framing the thought that "the properties of matter might have been such as to render a totally different set of laws axiomatic." I will not stop to make the inquiry whether matter, having properties fundamentally unlike its present ones, can be conceived; though such an inquiry, leading to the conclusion that no conception of the kind is possible, would show that the proposition is merely a verbal one. It will suffice if I examine the nature of this proposition that "the properties of matter *might have been*" other than they are. Does it express an experimentally-ascertained truth? If so, I invite Prof. Tait to describe the experiments. Is it an intuition? If so, then, along with doubt of an intuitive belief concerning things *as they are*, there goes confidence in an intuitive belief concerning things *as they are not*. Is it an hypothesis? If so, the implication is that a cognition of which the negation is inconceivable (for an axiom is such) may be discredited by inference from that which is not a cognition at all, but simply a supposition. Does the reviewer admit that no conclusion can have a validity greater than is possessed by its premises? or will he say that the trustworthiness of cognitions increases in proportion as they are the more inferential? Be his answer what it may, I shall take it as unquestionable that nothing concluded can have a warrant higher than that from which it is concluded, though it may have a lower. Now, the elements of the proposition before us are these: *As* "the properties of matter might have been such as to render a totally different set of laws axiomatic" (*therefore*) "these laws [now in force] must be considered as resting . . . . not on intuitive perception:" that is, the intuitions in which these laws are recognized must not be held authoritative. Here the cognition posited as premiss is, that the properties of the matter might have been other than they are; and the conclusion is that our intuitions relative to existing properties are uncertain. Hence, if this conclusion is valid, it is valid because the cognition or intuition respecting what might have been is more trustworthy than the cognition or intuition respecting what is! Skepticism respecting the deliverances of consciousness about things as they are is based upon faith in a deliverance of consciousness about things as they are not!

I go on to remark that this "authoritative expression of disapproval" by which I am supposed to be silenced, even were its allegation as valid as it is fallacious, would leave wholly untouched the real issue. I pointed out how Prof. Tait's denial, that any physical truths could be reached *a priori*, was contradicted by his own statement respecting physical axioms. The question thus raised the reviewer evades, and substitutes another with which I have just dealt. Now I bring forward again the evaded question.

In the passage I quoted, Prof. Tait, besides speaking of physical

"*axioms*," says of them that due familiarity with physical phenomena gives the power of seeing "*at once*" "their *necessary* truth." These last words, which express his conception of an axiom, express also the usual conception. An axiom is defined as a "self-evident truth," or a truth that is seen *at once;* and the definition otherwise worded is—a "truth so evident *at first sight* that no process of reasoning or demonstration can make it plainer." Now, I contend that Prof. Tait, by thus committing himself to a definition of physical axioms identical with that which is given of mathematical axioms, tacitly admits that they have the same *a priori* character; and I further contend that no such nature as that which he describes physical axioms to have, can be acquired by experiment or observation during the life of an individual. Axioms, if defined as truths of which the *necessity* is at once seen, are thereby defined as truths of which the negation is inconceivable; and the familiar contrast between them and the truths established by individual experiences is, that these last never become such that their negations are inconceivable, however multitudinous the experiences may be. Thousands of times has the sportsman heard the report that follows the flash from his gun, but still he can imagine the flash as occurring silently; and countless daily experiments on the burning of coal leave him able to conceive coal as remaining in the fire without ignition. So that the "convictions drawn from observation and experiment" during a single life can never acquire that character which Prof. Tait admits physical axioms to have: in other words, physical axioms cannot be derived from personal observation and experiment. Thus, otherwise applying the reviewer's words, I "doubt whether we should have heard aught of this quotation" to which he calls my attention, had he studied the matter more closely; and he "leaves us indebted to" him "for the discovery of" a passage which serves to make clearer the untenability of the doctrine he so dogmatically affirms.

I turn now to what the reviewer says concerning the special arguments I used to show that the first law of motion cannot be proved experimentally. After a bare enunciation of my positions, he says:

> "On the utterly erroneous character of these statements we do not care to dwell, we wish simply to call our reader's attention to the conclusion arrived at. Is that a disproof of the possibility of an inductive proof? We thought that every tolerably educated man was aware that the proof of a scientific law *consisted in* showing that, *by* assuming its truth, we could explain the observed phenomena."

Probably the reviewer expects his readers to conclude that he could easily dispose of the statements referred to if he tried. Among scientific men, however, this cavalier passing over of my arguments will perhaps be ascribed to another cause. I will give him my reason for saying this. Those arguments, read in proof by one of the most eminent physicists, and by a specially-honored mathematician, had their entire concurrence; and I have since had from another mathe-

matician, standing among the very first, such qualified agreement as is implied in saying that the first law of motion cannot be proved by terrestrial observations (which is in large measure what I undertook to show in the paragraphs which the reviewer passes over so contemptuously). But his last sentence, telling us what he thought "every tolerably educated man was aware" of, is the one which chiefly demands attention. In it he uses the word *law*—a word which, conveniently wide in meaning, suits his purpose remarkably well. But we are here speaking of physical *axioms*. The question is, whether the justification of a physical axiom consists in showing that, by assuming its truth, we can explain the observed phenomena. If it does, then all distinction between hypothesis and axiom disappears. Mathematical axioms, for which there is no other definition than that which Prof. Tait gives of physical axioms, must stand on the same footing. Henceforth we must hold that our warrant for asserting that "things which are equal to the same thing are equal to one another" consists in the observed truth of the geometrical and other propositions deducible from it and the associated axioms—the *observed* truth, mind; for the fabric of deductions yields none of the required warrant until these deductions have been tested by measurement. When we have described squares on the three sides of a right-angled triangle, cut them out in paper, and, by weighing them, have found that the one on the hypothenuse balances the other two, then we have got a fact which, joined with other facts similarly ascertained, justifies us in asserting that things which are equal to the same thing are equal to one another! Even as it stands, this implication will not, I think, be readily accepted; but we shall find that its unacceptability becomes still more conspicuous when the analysis is pursued to the end.

Continuing his argument to show that the laws of motion have no *a priori* warrant, the reviewer says:

> "Mr. Spencer asserts that Newton gave no proof of the Laws of Motion. The whole of the 'Principia' was the proof, and the fact that, taken as a system, these laws account for the lunar and planetary motions, is the warrant on which they chiefly rest to this day."

I have first to point out that here, as before, the reviewer escapes by raising a new issue. I did not ask what he thinks about the "Principia" and the proof of the laws of motion by it; nor did I ask whether others at this day hold the assertion of these laws to be justified mainly by the evidence the Solar System affords. I asked what Newton thought. The reviewer had represented the belief that the second law of motion is knowable *a priori*, as too absurd even for me openly to enunciate. I pointed out that since Newton enunciates it openly under the title of an axiom, and offers no proof whatever of it, he did explicitly what I am blamed for doing implicitly. And thereupon I invited the reviewer to say what he thought of Newton. Instead of

answering, he gives me his opinion to the effect that the laws of motion are proved true by the truth of the "Principia" deduced from them. Of this hereafter. My present purpose is to show that Newton did not say this, and gave every indication of thinking the contrary. He does not call the laws of motion "hypotheses;" he calls them "axioms." He does not say that he assumes them to be true *provisionally*, and that the warrant for accepting them as actually true will be found in the astronomically-proved truth of the deductions. He lays them down just as mathematical axioms are laid down—posits them as truths to be accepted *a priori*, from which follow consequences which must therefore be accepted. And, though the reviewer thinks this an untenable position, I am quite content to range myself with Newton in thinking it a tenable one—if, indeed, I may say so without undervaluing the reviewer's judgment. But now, having shown that the reviewer evaded the issue I raised, which it was inconvenient for him to meet, I pass to the issue he substitutes for it. I will first deal with it after the methods of ordinary logic, before dealing with it after the methods of what may be called transcendental logic.

To establish the truth of a proposition postulated, by showing that the deductions from it are true, requires that the truth of the deductions shall be shown in some way that does not directly or indirectly assume the truth of the proposition postulated. If, setting out with the axioms of Euclid, we deduce the truths that "the angle in a semicircle is a right angle," and that "the opposite angles of any quadrilateral figure described in a circle are together equal to two right angles," and so forth; and, if, because these propositions are true, we say that the axioms are true, we are guilty of a *petitio principii*. I do not mean simply that, if these various propositions are taken as true on the strength of the demonstrations given, the reasoning is circular, because the demonstrations assume the axioms, but I mean more—I mean that any supposed *experimental* proof of these propositions, by measurement, itself assumes the axioms to be justified. For, even when the supposed experimental proof consists in showing that some two lines, demonstrated by reason to be equal, are equal when tested in perception, the axiom, that things which are equal to the same thing are equal to one another, is taken for granted. The equality of the two lines can be ascertained only by carrying from the one to the other some measure (either a movable marked line or the space between the points of compasses), and by assuming that the two lines are equal to one another, because they are severally equal to this measure. The ultimate truths of mathematics, then, cannot be established by any experimental proof that the deductions from them are true; since the supposed experimental proof takes them for granted. The same thing holds of ultimate physical truths. For the alleged *a posteriori* proof of these truths has a vice exactly analogous to the vice I have just indicated. Every evidence yielded by astronomy,

that the axioms called "the laws of motion" are true, resolves itself into a fulfilled prevision that some celestial body or bodies will be seen in a specified place, or in specified places, in the heavens, at some assigned time. Now, the day, hour, and minute, of this verifying observation can be fixed only on the assumption that the Earth's motion in its orbit and its motion round its axis continue undiminished. Mark, then, the parallelism. One who chose to deny that things which are equal to the same thing are equal to one another, could never have it proved to him by showing the truth of deduced propositions; since the testing process would in every case assume that which he denied. Similarly, one who refused to admit that motion, uninterfered with, continues in the same straight line at the same velocity, could not have it proved to him by the fulfillment of an astronomical prediction; because he would say that both the spectator's position in space and the position of the event in time were those alleged only if the Earth's motions of translation and rotation were undiminished, which was the very thing he called in question. Evidently such a skeptic might object that the seeming fulfillment of the prediction, say a transit of Venus, may be effected by various combinations of the changing positions of Venus, of the Earth, and of the spectator on the Earth. The appearances may occur as anticipated, though Venus is at some other place than the calculated one; provided the Earth also is at some other place, and the spectator's position on the Earth is different. And, if the first law of motion is not assumed, it must be admitted that the Earth and the spectator *may* occupy these other places at the predicted time: supposing that, in the absence of the first law, this predicted time can be ascertained, which it cannot. Thus the testing process inevitably begs the question.

That the perfect congruity of all astronomical observations with all deductions from "the laws of motion" gives coherence to this group of intuitions and perceptions, and so furnishes a warrant for the entire aggregate of them which it would not have were any of them at variance, is unquestionable. But it does not therefore follow that astronomical observations can furnish a test for *each individual assumption*, out of the many which are simultaneously made. I will not dwell on the fact that the process of verification assumes the validity of the assumptions on which acts of reasoning proceed; for the reply may be that these are shown to be valid apart from astronomy. Nor will I insist that the assumptions underlying mathematical inferences, geometrical and numerical, are involved; since it may be said that these are justifiable separately by our terrestrial experiences. But, passing over all else that is taken for granted, it suffices to point out that, in making every astronomical prediction, the three laws of motion and the law of gravitation are *all* assumed; that, if the first law of motion is to be held proved by the fulfillment of the prediction, it can be so only by taking for granted that the two other laws of

motion and the law of gravitation are true; and that non-fulfillment of the prediction would not disprove the first law of motion, since the error might be in one or other of the three remaining assumptions. Similarly with the second law: the astronomical proof of it depends on the truth of the accompanying assumptions. So that the warrants for the assumptions A, B, C, and D, are respectively such that A, B, and C, being taken as trustworthy, prove the validity of D; D being thus proved valid, joins C, and B, in giving a character to A; and so throughout. The result is that every thing comes out right if they happen to be all true; but, if one of them is false, it may destroy the characters of the other three, though these are in reality exact. Clearly, then, astronomical prediction and observation can never test any one of the premises by itself. They can only justify the entire aggregate of premises, mathematical and physical, joined with the entire aggregate of reasoning processes leading from premises to conclusions.

I now recall the reviewer's "thought," uttered in his habitual manner, "that every tolerably educated man was aware that the proof of a scientific law *consisted in* showing that, *by* assuming its truth, we could explain the observed phenomena." Having from the point of view of ordinary logic dealt with this theory of proof as applied by the reviewer, I proceed to deal with it from the point of view of transcendental logic, as I have to charge the reviewer with either being ignorant of, or else deliberately ignoring, a cardinal doctrine of the System of Philosophy he professes to review—a doctrine set forth not in those four volumes of it which he seems never to have looked into, but in the one volume of it he has partially dealt with. For this principle which, in respect to scientific beliefs, he enunciates for my instruction, is one which, in "First Principles," I have enunciated in respect to all beliefs whatever. In the chapter on the "Data of Philosophy," where I have inquired into the legitimacy of our modes of procedure, and where I have pointed out that there are certain ultimate conceptions without which the intellect can no more stir "than the body can stir without help of its limbs," I have inquired how their validity or invalidity is to be shown; and I have gone on to reply that—

> "Those of them which are vital, or cannot be severed from the rest without mental dissolution, must be assumed as true *provisionally* . . . . leaving the assumption of their unquestionableness to be justified by the results.
>
> "§ 40. How is it to be justified by the results? As any other assumption is justified—by ascertaining that all the conclusions deducible from it correspond with the facts as directly observed—by showing the agreement between the experiences it leads us to anticipate and the actual experiences. There is no mode of establishing the validity of any belief, except that of showing its entire congruity with all other beliefs."

Proceeding avowedly and rigorously on this principle, I have next inquired what is the fundamental *process* of thought by which this con-

gruity is to be determined, and what is the fundamental *product* of thought yielded by this process. This fundamental product I have shown to be the coexistence of subject and object; and then, describing this as a postulate to be justified by "its subsequently-proved congruity with every result of experience, direct and indirect," I have gone on to say that "the two divisions of self and not-self are redivisible into certain most general forms, the reality of which Science, as well as Common-Sense, from moment to moment assumes." Nor is this all. Having thus assumed, *only provisionally*, this deepest of all intuitions, far transcending an axiom in self-evidence, I have, after drawing deductions occupying four volumes, deliberately gone back to the assumption ("Principles of Psychology," § 386). After quoting the passage in which the principle was laid down, and after reminding the reader that the deductions drawn had been found congruous with one another, I have pointed out that it still remained to ascertain whether this primordial assumption was congruous with all the deductions; and have thereupon proceeded, throughout eighteen chapters, to show the congruity. And yet, having the volumes before him in which this principle is set forth with a distinctness and acted upon with a deliberation which I believe are nowhere exceeded, the reviewer enunciates for my benefit this principle of which he "thought that every tolerably educated man was aware!" He enunciates it as applying to limited groups of beliefs to which it does not apply; and shuts his eyes to the fact that I have avowedly and systematically acted upon it in respect to the entire aggregate of our beliefs (axioms included) for which it furnishes the ultimate justification!

Here I must add another elucidatory statement, which would have been needless had the reviewer read that which he criticises. His argument proceeds throughout on the assumption that I understand *a priori* truths after the ancient manner, as truths independent of experience; and he shows this more than tacitly, where he "trusts" that he is "attacking one of the last attempts to deduce the laws of Nature from our inner consciousness." Manifestly, a leading thesis of one of the works he professes to review is entirely unknown to him—the thesis that forms of thought, and consequently the intuitions which those forms of thought involve, result entirely from the effects of experiences, organized and inherited. With the "Principles of Psychology" before him, not only does he seem unaware that it contains this doctrine, but, though this doctrine, set forth in its first edition published nearly twenty years ago, has gained considerable currency, he seems never to have heard of it. The implication of this doctrine is, not that the "laws of Nature" are deducible from "our inner consciousness," but that our consciousness has a preëstablished correspondence with such of those laws (simple, perpetually presented, and never negatived) as have, in the course of practically-infinite ancestral experiences, registered themselves in our nervous structure. Had he

taken the trouble to acquaint himself with this doctrine, he would have learned that the intuitions of axiomatic truths are regarded by me as latent in the inherited brain, just as bodily reflex actions are latent in the inherited nervous centres of a lower order; that such latent intuitions are made potentially more distinct by the greater definiteness of structure due to individual action and culture; and that thus, axiomatic truths, having a warrant entirely *a posteriori* for the race, have for the individual a warrant which, substantially *a priori*, is made complete *a posteriori*. And he would then have learned that, as, during evolution, Thought has been moulded into increasing correspondence with Things, and as such correspondence, tolerably complete in respect of the simple, ever-present, and invariable relations, as those of space, has made considerable advance in respect of the primary dynamical relations, the assertion that the resulting intuitions are authoritative is the assertion that the simplest uniformities of Nature, as experienced throughout an immeasurable past, are better known than they are as experienced during an individual life. All which conceptions, however, being, as it seems, unheard of by the reviewer, he regards my trust in these primordial intuitions as like that of the Ptolemists in their fancies about perfection!

Thus far my chief antagonists, passive, if not active, have been Prof. Tait and, by implication, Sir William Thomson, his coadjutor in the work quoted against me—men of standing, and the last of them of world-wide reputation as a mathematician and physicist. Partly because the opinions of such men demand attention, I have dealt with the questions raised at some length; and partly, also, because the origin and consequent warrant of physical axioms are questions of general and permanent interest. The reviewer, who, by citing against me these authorities, has gained for some of his criticisms consideration they would otherwise not deserve, I must, in respect of his other criticisms, deal with very briefly. Because, for reasons sufficiently indicated, I did not assail sundry of his statements, he has reiterated them as unassailable. I will here add no more than is needful to show how groundless is his assumption.

What the reviewer says on the metaphysical aspects of the propositions we distinguish as physical, need not detain us long. His account of my exposition of "Ultimate Scientific Ideas," he closes by saying of me that "he is not content with less than showing that all our fundamental conceptions are inconceivable." Whether the reviewer knows what he means by an inconceivable conception, I cannot tell. It will suffice to say that I have attempted no such remarkable feat as that described. My attempt has been to show that objective activities, together with their objective forms, are inconceivable by us—that such symbolic conceptions of them as we frame, and are obliged to use, are proved, by the alternative contradictions which a

final analysis of them discloses, to have no likeness to the realities. But the proposition that objective existence cannot be rendered in terms of subjective existence, the reviewer thinks adequately expressed by saying that "our fundamental conceptions" (subjective products) "are inconceivable" (cannot be framed by subjective processes)! Giving this as a sample from which may be judged his fitness for discussing these ultimate questions, I pass over his physico-metaphysical criticisms, and proceed at once to those which his special discipline may be assumed to render more worthy of attention.

Quoting a passage relative to the law that "all central forces vary inversely as the squares of the distances," he derides the assertion that "this law is not simply an empirical one, but one deducible mathematically from the relations of space—one of which the negation is inconceivable." Now, whether this statement can or cannot be fully justified, it has at any rate none of that absurdity alleged by the reviewer. When he puts the question: "Whence does he [do I] get this?" he invites the suspicion that his mind is not characterized by much excursiveness. It seems never to have occurred to him that, if rays like those of light radiate in straight lines from a centre, the number of them falling on any given area of a sphere described from that centre will diminish as the square of the distance increases, because the surfaces of spheres vary as the squares of their radii. For, if this has occurred to him, why does he ask whence I get the inference? The inference is so simple a one as naturally to be recognized by those whose thoughts go a little beyond their lessons in geometry.[1] If the reviewer means to ask whence I get the implied assumption that central forces act only in straight lines, I reply that this assumption has a warrant akin to that of Newton's first axiom, that a moving body will continue moving in a straight line, unless interfered with. For that the force exerted by one centre on another should act in a curved line, implies the conception of some second force, complicating the direct effect of the first. And, even could a central force be truly conceived as acting in lines not straight, the *average* distribution of its effects upon the inner surface of the surrounding sphere would still follow the same law. Thus, whether or not the law be accepted on *a priori* grounds, the assumed absurdity of representing it to have *a priori* grounds is not very obvious. Respecting this statement of mine, the reviewer goes on to say:

"This is a wisdom far higher than that possessed by the discoverer of the great law of attraction, who was led to consider it from no cogitations on the relations of space, but from observations of the movements of the planets; and

[1] That I am certainly not singular in this view is shown to me, even while I write, by the just-issued work of Prof. Jevons on the "Principles of Science: a Treatise on Logic and Scientific Method." In vol. ii., p. 141, Prof. Jevons remarks respecting the law of variation of the attractive force, that it "is doubtless connected at this point with the primary properties of space itself, and is so far conformable to our necessary ideas."

who was so far from rising to that clearness of view of the truth of his great discovery, which is expressed by the phrase, 'its negation is inconceivable,' that he actually abandoned it for a time, because (through an error in his estimate of the earth's diameter) it did not seem fully to account for the motion of the moon."

To the first clause in this sentence, I have simply to give a direct denial; and to assert that neither Newton's "observations of the movements of the planets," nor other such observations continued by all astronomers for all time, would yield "the great law of attraction." Contrariwise, I contend that when the reviewer says, by implication, that Newton had no antecedent hypothesis respecting the cause of the planetary motions, he (the reviewer) is not only going beyond his possible knowledge, but he is asserting that which even a rudimentary acquaintance with the process of discovery might have shown him was impossible. Without framing, beforehand, the supposition that there was at work an attractive force varying inversely as the square of the distance, no such comparison of observations as that which led to the establishment of the theory of gravitation could have been made. On the second clause of the sentence, in which the reviewer volunteers for my benefit the information that Newton "actually abandoned" his hypothesis for a while because it did not bring out right results, I have first to tell him that, in an early number of the very periodical containing his article,[1] I cited this fact (using these same words) at a time when he was at school, or before he went there.[2] I have next to assert that this fact is irrelevant; and that Newton, while probably seeing it to be a necessary implication of geometrical laws that central forces vary inversely as the squares of the distances, did not see it to be a necessary implication of any laws, geometrical or dynamical, that there exists a force by which the celestial bodies affect one another; and therefore doubtless saw that there was no *a priori* warrant for the doctrine of gravitation. The reviewer, however, aiming to substitute for my "confused notions" his own clear ones, wishes me to identify the proposition—Central forces vary inversely as the squares of the distances—with the proposition—There is a cosmical force which varies inversely as the squares of the distances. But I decline to identify them; and I suspect that a considerable distinction between them was recognized by Newton. Lastly, apart from all this, I have to point out that, even had Newton thought the existence of an attractive force throughout space was an *a priori* truth, as well as the law of variation of such a force if it existed, he would still, naturally enough, pause before asserting this law, when he found his deductions from it did not correspond with the facts. To

[1] *See* Essay on "The Genesis of Science," in the *British Quarterly Review* for July, 1854, p. 127.

[2] I do not say this at random. The reviewer, who has sought rather to make known than to conceal his identity, took his degree in 1868.

suppose otherwise, is to ascribe to him a rashness which no disciplined man of science could be guilty of.

See, then, the critical capacity variously exhibited in the space of a single sentence. The reviewer, quite erroneously, thinks that observations unguided by hypotheses suffice for physical discoveries. He seems unaware that, on *a priori* grounds, the law of the inverse square had been suspected as the law of some cosmical force, before Newton. He asserts, without warrant, that no such *a priori* conception preceded, in Newton's mind, his observations and calculations. He confounds the law of variation of a force with the existence of a force varying according to that law. And he concludes that Newton could have had no *a priori* conception of the law of variation, because he did not assert the existence of a force varying according to this law in defiance of the evidence as then presented to him!

Now that I have analyzed, with these results, the first of his criticisms, the reader will neither expect me to waste time in similarly dealing with the rest *seriatim*, nor will he wish to have his own time occupied in following the analysis. To the evidence thus furnished of the reviewer's fitness for the task he undertakes, it will suffice if I add an illustration or two of the *animus* which leads him to make grave imputations on trivial grounds, and to ignore the evidence which contradicts his interpretations.

Because I have spoken of a balanced system, like that formed by the sun and planets, as having the "peculiarity, that though the constituents of the system have relative movements, the system, as a whole, has no movement," he unhesitatingly assumes me to be unaware that, in a system of bodies whose movements are not balanced, it is equally true that the centre of gravity remains constant. Ignorance of a general principle in dynamics is alleged against me solely because of this colloquial use of the word "peculiarity," where I should have used a word (and there is no word perfectly fit) free from the implication of exclusiveness. If the reviewer were to assert that arrogance is a "peculiarity" of critics; and if I were thereupon to charge him with entire ignorance of mankind, many of whom besides critics are arrogant, he would rightly say that my conclusion was a very large one to draw from so small a premise.

To this example of strained inference I will join an example of what seems like deliberate misconstruction. From one of my essays (not among the works he professes to deal with) the reviewer, to strengthen his attack, brings a strange mistake; which, even without inquiry, any fair-minded reader would see must be an oversight. A statement true of a single body acted on by a tractive force, I have inadvertently pluralized; being so possessed by another aspect of the question, as to overlook the obvious fact that with a plurality of bodies the statement became untrue. Not only, however, does the reviewer ignore various evidences furnished by the works before him,

that I could not really think what I had there said, but he ignores a direct contradiction contained in the paragraph succeeding that from which he quotes. So that the case stands thus: On two adjacent pages I have made two opposite statements, both of which I cannot be supposed to believe. One of them is right; and this the reviewer assumes I do not believe. One of them is glaringly wrong; and this the reviewer assumes I do believe. Why he made this choice no one who reads his criticism will fail to see.

Even had his judgments more authority than is given to them by his mathematical honors, this brief characterization would, I think, suffice. Perhaps already, in rebutting the assumption that I did not answer his allegations because they were unanswerable, I have ascribed to them an unmerited importance. For the rest, suggesting that their value may be measured by the value of that above dealt with as a sample, I leave them to be answered by the works they are directed against.

Here I end. The foregoing pages, while serving, I think, the more important purpose of making clearer the relations of physical axioms to physical knowledge, incidentally justify the assertion that the reviewer's charges of fallacious reasoning and ignorance of the nature of proof recoil on himself. When, in his confident way, he undertakes to teach me the nature of our warrant for scientific beliefs, ignoring absolutely the inquiry contained in "Principles of Psychology," concerning the relative values of direct intuitions and reasoned conclusions, he lays himself open to a sarcasm which is sufficiently obvious. And when a certain ultimate principle of justification for our beliefs, set forth and acted upon in the "System of Synthetic Philosophy" more distinctly than in any other work, is enunciated by him for my instruction, as one which he "thought that every tolerably educated man was aware" of, his course is one for which I find no fit epithet in the vocabulary I permit myself to use. That in some cases he has shown eagerness to found charges on misinterpretations little less than deliberate, has been sufficiently shown; as also that, in other cases, his own failure to discriminate is made the ground for ascribing to me beliefs that are manifestly untenable. Save in the single case of a statement respecting collisions of bodies, made by me without the needful qualification, I am not aware of any errors he detects, except errors of oversight or those arising from imperfect expression and inadequate exposition. When he unhesitatingly puts the worst constructions on these, it cannot be because his own exactness is such that no other constructions occur to him; for he displays an unusual capacity for inadvertencies, and must have had many experiences showing him how much he might be wronged by illiberal interpretations of them. One who in twenty-three professed extracts makes fifteen mistakes—words omitted, or added, or substituted—should not need reminding how largely mere oversight may raise suspicion of something worse. One

who shows his notions of accurate statement by asserting that, as I substitute "persistence" for "conservation," I therefore identify Persistence of *Force* with Conservation of *Energy*, and debits me with the resulting incongruities—one who, in pursuance of this error, confounds a special principle with the general principle it is said to imply, and thereupon describes a wider principle as being included in a narrower (p. 481)—one who speaks of our "inner consciousness" (p. 488), so asserting, by implication, that we have an outer consciousness—one who talks of an inconceivable conception; ought surely to be aware how readily lax expressions may be turned into proofs of absurd opinions. And one who, in the space of a few pages, falls into so many solecisms, ought to be vividly conscious that a whole volume thus written would furnish multitudinous statements from which a critic, moved by a spirit like his own, might evolve abundant absurdities; supplying ample occasion for blazoning the tops of pages with insulting words.

MORE ABOUT THE GRAPE-VINE PEST.

By CHARLES V. RILEY, M. A., Ph. D.

THE number of true (grape-vine) species of *Vitis*, with the cohering petals falling off when the flower opens, and bearing edible fruit, in the territory of the United States, is limited to nine. Of these, four species, viz., *Vitis Labrusca*, or Northern Fox; *Vitis æstivalis*, summer grape; *Vitis riparia*, river-bank grape; and *Vitis vulpina*, Southern Fox or Muscadine, are of chief practical consequence as having yielded our different cultivated varieties.

I will now proceed to indicate the relative susceptibility to the disease of the cultivated species and varieties. For the sake of conciseness, it will be best to indicate this susceptibility by letters and numerals, as follows:

0—No perfect leaf-galls found; or not at all subject to them.
a—Leaf-galls very rarely found.
b—Leaf-galls not unfrequently found.
c—Leaf-galls abundantly found, or very much subject to them.

0—Entirely free from root-lice.
1—Having the root-lice in unusually small numbers, but countervailing their punctures.
2—Root-lice often numerous; vines sometimes suffering from their effects.
3—Most subject to the root-lice and dying from their attacks whenever the conditions are favorable to their increase.

European Grape (*vinifera*), 0, 3.—The very few exceptions, where galls have been found on the leaves of this species, will scarcely invali-

date the rule that it is free from galls. So likewise the few exceptional instances of the successful out-door growth of this in Missouri, which have come to my notice, and which it is unnecessary to detail here, do not affect the rule, and only prove that such vines can be grown out-doors when not destroyed by Phylloxera.

River-Bank Grape (*riparia*).—Alvey, *a*, 2; Cornucopia (hybrid with *vinifera*), 0, 2; Clinton, *c*, 1, where the leaf-galls are very abundant, the root-lice are generally less so, and *vice versa*. The roots have such vitality that disorganization does not always seem to follow the puncture of the louse, and new rootlets put out from the swellings with great vigor and thrift; Delaware, *b*, 2; Golden Clinton, *a*, 1; Louisiana (some say a seedling of *vinifera*; others, again, believe it *æstivalis*), *a*, 1; Marion, *b*, 1; Othello (hybrid with *vinifera*), *a*, 2; Taylor, *c*, 1, much as with Clinton.

Summer Grape (*æstivalis*).—Herbemont, *a*, 1; Cunningham, 0, 1; Cynthiana, *a*, 1; Norton's Virginia, 0, 1; Rulander, 0, 1; Telegraph, 0, 1.

Northern Fox (*Labrusca*).—Catawba, 0, 3, suffering almost as badly as the varieties of *vinifera*; Challenge (hybrid with *vinifera*), 0, 1; Creveling, *a*, 2; Concord, *a*, 1; Diana, 0, 2; Dracut Amber, 0, 1; Goethe (hybrid with *vinifera*), 0, 2; Hartford, 0, 2; Iona, 0, 3; Isabella, or seedlings thereof, 0, 2; Israella, 0, 1; Ives, 0, 2; Martha, 0, 1; Northern Muscadine, 0, 1; Rebecca, 0, 2; Salem, 0, 2; Wilder (hybrid with *vinifera*), 0, 1.

Southern Fox (*vulpina*), 0, 0.—From the investigations of Prof. Planchon, it results, as was anticipated from the great differences in character which it presents, compared with the others, that this species is entirely free from the Phylloxera in any form. The root is not only very tough, but has a perceptibly bitter taste, which doubtless renders it obnoxious to the insect. Prof. Planchon examined it thoroughly in North Carolina, where other vines in the vicinity were suffering from the insect.

From the above enumeration we may gather that, with the exception of *vulpina*, no species of cultivated vine is entirely free from the attacks of either the gall-making or root-inhabiting types. Nevertheless *vinifera* is least and *riparia* most subject to the former; *æstivalis* least, and *vinifera* most subject to the latter.

Of *vinifera*, a few varieties, under certain conditions, seem to exhibit a power of resistance in this country; and it is singular that some relative immunity has not as yet been noticed among the varieties of this species in Europe.

Of *riparia*, the Clinton, Taylor, Golden Clinton, and Marion, seem best to resist.

Of *æstivalis*, all the species enumerated resist well, and I would especially mention Norton's Virginia, Herbemont, and Cunningham, as vigorous growers.

Of *Labrusca*, the Concord, Dracut Amber, Israella, Martha, North Carolina, and Wilder, resist well.

This enumeration is founded principally on the effects of Phylloxera in the central portion of Missouri, as ascertained by quite extensive notes and observations made during the past two years. I have also examined many of the varieties mentioned, with similar results, in portions of Kansas, Illinois, New Jersey, Pennsylvania, and New York. The Arnold's hybrids, so far examined, all suffer; but some of them more than others.

PROPHYLACTIC MEANS OF COPING WITH THE DISEASE.—It occurred to me that, by grafting the more susceptible on to the roots of the more resistant varieties, we might in a great measure counteract the disease, even if all other remedies failed. In the grape-growing districts of France, where the disease is so sweeping, and where the grape is so exclusively grown that its failure affects whole communities, the people may be obliged and can afford to go to much labor and expense in the use of insecticides to save their vines. Such insecticides may also be used in this country where it is desired to save a few choice vines regardless of expense and time. But I greatly fear that no direct remedy for such an underground enemy will ever be discovered, that will not entail too much labor and expense to be used, to any great extent, by our own grape-growers. These will either prefer to confine their attention to varieties which resist the enemy, or abandon the business entirely. Yet, if it shall once be demonstrated that varieties which now fail may be grown when grafted on to those which resist, I see no reason why it should not become as much a custom and a maxim among grape-growers to use some other vine as stock for such varieties as the Catawba, for instance, as it already is among pear-growers to use the quince, or among cherry-growers to use Mahaleb, Mazard, or Morello, as stocks.

In the course of a year or two we shall be able to fairly judge of the efficacy of the plan; for, aside from the trials that I am making in this country, others are being made on an extensive scale in France. Quite a number of plants for the purpose of experiment were sent over there from this country in the spring of 1872; and the demand has now become so great that a single firm, Isidor Bush & Co., of St. Louis, has this winter received orders for about four hundred thousand cuttings to be consigned to one place, Montpellier, and consisting of such varieties as have been recommended by myself and Prof. Planchon, as best resisting the disease. There is every reason to hope for the best results from these importations, as those vines, such as Herbemont, Cunningham, Concord, Clinton, etc., which best resist here, and which were planted there in 1871 and 1872 in Phylloxera-infested districts, have, thus far, done surprisingly well, as MM. J. Leenhardt, Pomier, V. Pulliat, and others, testify. Experience, so far as had in America, also promises the best results.

We have seen that the Southern Fox (*vulpina*) is the only species that is totally exempt from both leaf and root lice. This species is of no value whatever in the latitude of St. Louis, and does not flourish above latitude 35°. It cannot, therefore, be made of any avail here, and it is doubtful whether, in the blighted French vineyards, they will be able to profit much by its immunity. I fear that it will hardly flourish even in the extreme southern portion of that country; while the great difference between its wood and that of the other cultivated species must render it difficult to successfully graft these upon it.

Other Preventive Measures.—In planting a new vineyard the greatest care should be taken not to introduce the Phylloxera on the young plants; and a bath of weak lye or strong soap-suds before planting will, perhaps, prove the best safeguard.

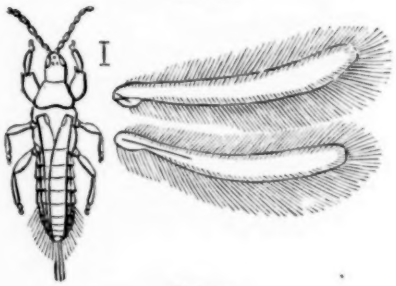
Remembering that the lice are spreading over the ground from July till fall, and principally in the months of August and September, a thorough sprinkling of the surface at this season with lime, ashes, sulphur, salt, or other substance destructive to insect-life, will no doubt have a beneficial effect in reducing their numbers and preventing their spread.

The insect has been found to thrive less, and to be, therefore, less injurious, in a sandy soil; while a mixture of soot with the soil has had a beneficial effect in destroying the pest. I have therefore recommended, for the more susceptible varieties, that they be planted in trenches, first prepared with a mixture of sand and soot: an addition of lime and ashes will also prove beneficial. There is every reason to believe that vines are rendered less susceptible to the disease by a system of pruning and training that will produce long canes and give them as nearly as possible their natural growth. Numerous instances are on record, and have come under my notice, of thrifty vines grown upon trees, or upon houses, with scarcely any pruning, and generally in firm, compact soil; while in the same neighborhood the same kinds of vines, in open culture, have been sickly or have failed.

Natural Enemies.—There are a number of different predaceous insects which serve to keep the leaf-lice in check; but, as the injury is mostly done underground, it will suffice to enumerate the principal of these in this connection. The most efficient is a black species of fringe-wing, or thrips, with white wings (*Thrips phylloxeræ* of my MS.). The egg, which is thrice as large as that of the louse, ellipsoidal and with a faceted surface, is deposited within the gall among the more legitimate inhabitants; and the young Thrips, which differ from their parents not only in lacking wings, but in being of a blood-red color, with only the extremities and the members black, play havoc with the lice. They are active, supple creatures, and turn up menacingly the posterior part of the body when disturbed. They are found in several different kinds of Phylloxera-galls, and do more than any other species to keep the leaf-inhabiting grape Phylloxera within bounds.

The next most efficient aid in the destruction of the leaf-lice is found among the lace-wing flies, one species of which, more especially, viz., the Weeping Lace-wing (*Chrysopa plorabunda* Fitch), I find very frequently within the galls, devouring their contents. These

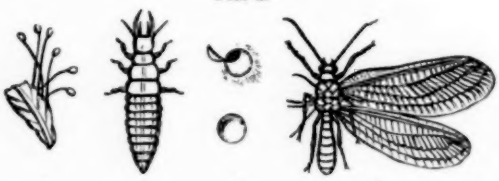
FIG. 1.



THRIPS.

flies are known as well by their brilliantly golden eyes as by the peculiarly offensive odor, as of human ordure, which some of them emit. The eggs are adroitly deposited (Fig. 2, *a*) by the parent at the tips of long silk-like stalks, in order to prevent first-born larvæ from exer-

FIG. 2.



LACE-WING FLY.—*a*, eggs; *b*, larva; *c*, cocoon; *d*, fly, the wings to the left omitted.

cising their cannibalistic propensities on their yet unborn brethren. The larva (Fig. 2, *b*) is very rapacious, and, when ready to transform, winds itself up into a wonderfully small cocoon (considering the size of the insect which makes it and which issues from it), which is spun

FIG. 3.

CONVERGENT LADYBIRD; a larva, pupa, and beetle.

FIG. 4.

SYRPHUS LARVA.

from the extremity of the body, and from which it issues, when about to acquire wings, through a neatly-cut, circular aperture. Next in order, as Phylloxera enemies, may be mentioned the Ladybirds (*Cocci-*

nella), especially certain small dark-brown species belonging to the genus *Scymnus*, and whose young, thickly covered with white and evenly-shorn tufts of a cottony secretion, are frequently found at their good work within the galls. Following these may be mentioned, as auxiliaries, certain Syrphus-fly larvæ, which, being blind, go groping about among the eggs and young lice, which they seize and suck to

FIG. 5.

SYRPHUS FLY.

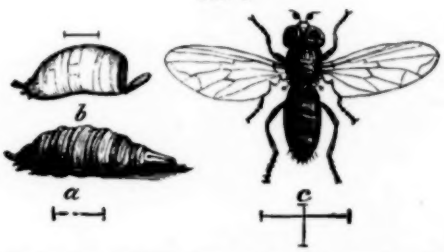
FIG. 6.

INSIDIOUS FLOWER-BUG.

death. Also certain orange larvæ of a smaller two-winged fly (*Leucopis*); a few genuine bugs (*Heteroptera*), and notably the Insidious Flower-bug (*Anthocoris insidiosus*, Say, Fig. 6), and certain smaller Hymenopterous parasites.

The enemies known to attack the Phylloxera underground are, naturally enough, fewer in number. In one instance I have found a Scymnus larva at the work six inches below the surface, and there is a Syrphus fly (*Pipiza radicum*, W. and R., Fig. 7) whose larva lies underground and feeds both on the apple-tree-root louse, and on this

FIG. 7.

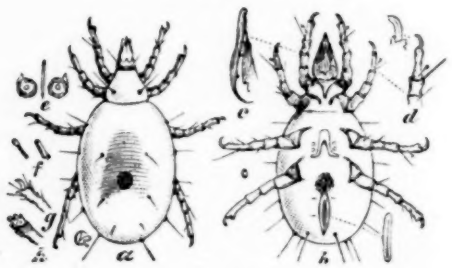


ROOT-LOUSE SYRPHUS FLY.—*a*, larva; *b*, pupa; *c*, fly.

grape-root louse. Wonderful indeed is the instinct which teaches the blind larva to penetrate the soil in search of its prey; for the egg must necessarily be laid at the surface. But, though the underground enemies of its own class are few, I have discovered a mite which preys upon this root-inhabiting type, and which renders efficient aid in keep-

ing it in check in this country. This mite (*Tyroglyphus phylloxeræ* Planchon and Riley, Fig. 8) belongs to the same genus as the cheese and meal mites (*T. zivo*, Linn.), and the species (*T. entomophagus* Laboulbène) which infests preserved insects, and is such a pest in cabinets.

Fig. 8.



Phylloxera Mite.—*a*, dorsal; *b*, ventral view of female; *c*, mouth-parts magnified; *d*, *f*, *g*, *h*, forms of tarsal appendages; *e*, ventral tubercles of male.

Direct Remedies.—The leaf-lice, which do not play such an important part in the disease as was at first supposed, may be controlled with sufficient ease by a little care in destroying the first galls which appear, and in pruning and destroying the terminal growth of infested vines later in the season. The root-lice are not so easily reached. As the effort will be according to the exigency, we may very naturally look to France for a direct remedy, if ever one be discovered. But, of all the innumerable plans, patented or non-patented, that have been proposed, of all the many substances that have been experimented with, under the stimulus of a large national reward, no remedy has yet been discovered which gives entire satisfaction, or is applicable to all conditions of soil. Nor is it likely that such a remedy ever will be discovered. A large majority of the remedies proposed, such as the planting of *Madia sativa* among the vines, or inoculating them with the essence of *Eucalyptus globulus*, are, upon their face, absurd. These we will pass by, and briefly mention only those which have been more or less productive of good.

Submersion, where practicable, and where it is total and sufficiently prolonged, is a perfect remedy. This is what even the closet-student might expect, as he finds that excessive moisture is very disastrous to the lice. M. Louis Foucon, of Graveson (Bouches-du-Rhône), France, has abundantly proved its efficacy, and has, by means of it, totally annihilated the insect from his vineyard, which was suffering from it four years ago. From his experience we may draw the following conclusions: 1. The best season to submerge is in autumn (September and October), when the lice are yet active, and the vines have ceased growing. Submergence for twenty-five to thirty days, at this season, will generally rout the lice. 2. A submergence of forty to fifty days

in winter is required, and even where the water is allowed to remain during the whole of this season the vineyard does not suffer. 3. A vineyard should never be inundated for a longer period than two days in summer, or during growth; and though these brief inundations at that season affect only the few lice near the surface, and are by no means essential, they are nevertheless important auxiliaries to the more thorough fall or winter submersion, as they destroy the few lice which are always invading a vineyard in infested districts. These summer inundations will be necessary only after the winged insects begin to appear; and three or four, each lasting less than two days, made between the middle of July and the fall of the leaf, will effect the end desired. 4. An embankment should be made around the vineyard, in order that the water may evaporate and permeate the earth, but not run off and carry away any nutritive properties of the soil.

The varied success which has attended the different attempts to rout the enemy by inundation, is owing to the lack of thoroughness in many of them. The ground must be thoroughly soaked for a sufficient length of time. Temporary irrigation does not accomplish the end, for the reason that it does not reach all the lice, and does not break up the numerous air-bubbles which form in the soil, and prevent the drowning of many of the insects.

On our best hilly vine-land thorough submersion is impracticable, but on our bottom-lands some of the grapes, which fail now, may be made to succeed by its means.

Of 140 different applications made by an intelligent and competent commission in the department of Hérault, France, most of the pure insecticides proved valueless. Many of them, such as carbolic acid, oil of cade, arsenious acid, sulphide of calcium, sulphide of mercury, arseniate of potash, etc., etc., will effectually kill the insect when brought in direct contact with it; but, in field-practice, they can either not be brought in this direct contact, or else cannot be used strong enough to kill all the lice without injuriously affecting the vine.

Carbolic acid added to water, at the rate of about one per cent., applied by pouring into deep holes, made by a crow-bar or auger, has given satisfactory results; and a thorough application of soot has also been strongly advocated by those who have tried it. In the experiments that I have been able to make, in a small way, a thorough mixing with the soil of a cheap carbolic powder, prepared by G. Mallinckrodt & Co., of St. Louis, has given good results.

The latest insecticide that has attracted attention and given great hopes in France is the bisulphide of carbon. It seems to have been used as early as 1869 by Baron Thenard, but was brought prominently before the public last autumn by Messrs. Monestier, Lautand, and D'Ortoman, who first proposed to introduce it at a great depth in the soil, so as to utilize its vapor. A vapor will naturally have the advan-

tage over a liquid, as it will more effectually permeate the soil and reach the lice. The following is the method of procedure in their own words:

"Make three holes around the vine, the depth to vary according to nature of soil, but generally about 2½ feet (80 centimetres). Hitherto we have made these holes with a pointed iron bar, driven by a maul. When the hole is made the bar is withdrawn, and a tube, furnished with a funnel at one end, is inserted in its place. About two ounces of sulphuret of carbon are then poured into the tube, which is immediately corked. . . . The vapor of this sulphuret of carbon permeates the soil, and impregnates all the roots of the vine. The gas engendered is not, like the liquid itself, fatal to the vine, but invigorates it. Its effects are, however, sure death to the insect, and, if a vine is examined eight days after the treatment, the lice are found dead and carbonized. At the end of fifteen days nothing but the effects of the lice is seen. Long and corroborative experience has demonstrated that about four ounces (100 grammes) of the liquid is sufficient for an ordinary vine; but sprinkling on the surface must be carefully avoided, as it is then very injurious to the vine; whereas as much as a pound may be made to penetrate the soil without injury to the roots."

Soon after the announcement of this method, I employed it as a test on three vines, which I knew to be infested with Phylloxera, using three ounces to the first, six ounces to the second, and nine ounces to the third, the soil being a light clayey loam. At the end of twelve days I found plenty of living lice on the first and second vines, and such were found long afterward, though in small numbers, up to the time of the freezing of the ground. On the third vine all the lice were evidently charred, but the vine was also plainly injured, as the leaves wilted as though they had been scorched, though, whether from the vapor issuing from the ground, or from the injury to the root, it was impossible to determine—I think, however, from the former, as the larger roots were yet alive late in the season, and the vine seems, at this writing, to be living.

After very careful and laborious experiments made in France at different points, and on different kinds of soil, by a commission specially charged with studying the action of this chemical, under the method proposed by Messrs. Monestier, Lautand, and D'Ortoman, it fails to fulfill the sanguine expectations of these gentlemen. The liquid is costly, its application is laborious, and there is great difficulty in reaching and killing all the lice without injuring the vine. Great caution must also be had in its use, as it is extremely volatile and explosive, the vapor igniting at a great distance from the vessel containing it.

While, therefore, not very satisfactory results have followed the use of pure insecticides, the application of fertilizers, intended to invigorate the vine, and at the same time injure the lice, has been more productive of good. Especially has this been the case with fertilizers rich in potassic salts and nitrogenous compounds, such as urine.

Sulphuret of potassium, dissolved in liquid manure; alkalino-sul-

phates, with copperas and rape-seed; potassic salts, with guano; soot and cinders, are, among other applications, most favorably mentioned.

RANGE OF THE INSECT IN AMERICA.—As already intimated, the insect is indigenous to the North American Continent. I have been able to trace its existence, with absolute certainty, as far back as 1834; for, in the herbarium of Dr. Engelmann, there are specimens of *Vitis monticola* (Buck) that were gathered that year in Texas by the botanist Berlandier, and which have Phylloxera galls upon the leaves; while specimens of *riparia* in the same collection, and gathered in Missouri in 1845, also have the leaves disfigured by the same gall.

We find, in consequence, that the insect is very generally distributed over the States. I have myself found it in Kansas, Iowa, Illinois, Missouri, Michigan, Ontario, New York, New Jersey, Pennsylvania, and Maryland, and have abundant evidence of its occurrence in Connecticut, District of Columbia, North Carolina, Texas, and as far south as Florida. It doubtless occurs in all the intermediate States. There is every reason to believe, however, that, like so many other animals which occur on the eastern slope of the Rocky Mountains, but are unknown on the western slope, this Phylloxera is not indigenous to the Pacific half of the continent. I have, so far, been unable to trace its existence with any certainty in California; and to its non-existence there the California grape-growers doubtless owe, in great part, their success in the cultivation of the European vine. Yet I have strong evidence that around Sonoma the insect already occurs, and has done much damage; and it may have been introduced either from the Eastern States or from Europe into other parts of that country. It, therefore, behooves our friends of the Golden State to carefully look into this matter, and to endeavor, by taking the proper precautionary steps, to prevent a repetition of the disasters which have followed the introduction and spread of Phylloxera in Europe.

INJURY CAUSED BY PHYLLOXERA IN AMERICA.—In this country, where, compared with Europe, land is so rich and abundant, we are apt to think lightly of injury to our crops, except when such injury becomes very great and wide-spread. It is a fact, long ago remarked by Dr. Fitch, State Entomologist of New York, that while in Europe the whole people become alarmed if a fifth of a given crop is destroyed by insects, the farmer here often thinks himself fortunate if he can save half the average yield from insect depredations. Vines have died year after year in our vineyards, and very little notice has been taken of the fact; while certain varieties have continually failed until they have come to be discarded as unprofitable and useless. Yet the day is fast coming when the growing of superior varieties, which have for the most part failed, will alone be remunerative; and I believe that nothing will so tend to enable us to successfully grow them as a thorough knowledge of Phylloxera, which is, in reality, the principal

cause of their failure. Take as an instance the case of the Catawba. It is in growing demand in the Mississippi Valley, as, so far, the best white-wine grape, and the only one extensively used in the manufacture of sparkling wines. Yet it is, in this part of the country, one of the most susceptible to the Phylloxera disease, and its successful growth becomes more and more uncertain. If by a thorough understanding of the disease, and by the system of grafting which I have suggested, this vine can be successfully grown in the Mississippi Valley, it is safe to say that the value of our vineyards will be doubled; as the Concord, which is now the main reliance, and which makes but an inferior wine, has already so glutted our markets as scarcely to pay the grower.

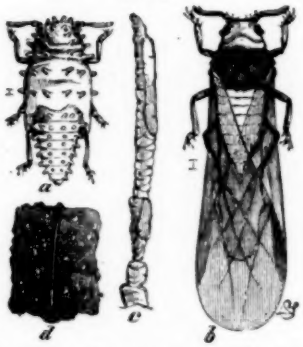
WHY THE INSECT IS MORE INJURIOUS IN EUROPE THAN IN AMERICA.—Without going into particulars, several good reasons may be given to explain the fact that Phylloxera is more devastating in the vineyards of France than in our own. There exists a certain harmony between the indigenous fauna and flora of a country, and our native vines are such as from their inherent peculiarities have best withstood the attacks of the insect. The European vine, on the contrary, succumbs more readily, not only because of its more tender and delicate nature, but because it has not been accustomed to the disease—there being, doubtless, a parallel between this case and the well-known fact that diseases and parasites which are comparatively harmless among peoples long accustomed to them, become virulent and often fatal when first introduced among hitherto uncontaminated peoples.

Then the particular natural enemies of the insect which belong to its own class, and which in this country help to keep it within due bounds, are lacking in Europe; and it will require some time before the closely allied European predaceous species will prey upon and check it there to the same extent.

The Phylloxera will, also, other things being equal, have an advantage in those countries where the mildness and shortness of the winter allow an increase in the annual number of its generations. Finally, the differences in soil and in modes of culture have no insignificant bearing on the question in hand. Though Phylloxera, in both types, is found on our wild vines, it is very doubtful if such wild vines, in a state of nature, are ever killed by it. With their far-reaching arms embracing shrub and tree, their climbing habit unchecked by the pruner's knife; these vines have a corresponding length and depth of root, which render them less susceptible to injury from an underground enemy. Our own method of growing on trellis approaches more nearly these natural conditions than that employed in the ravaged French districts, where the vines are grown in greater proximity and allowed to trail on the ground, or are supported by a single stake.

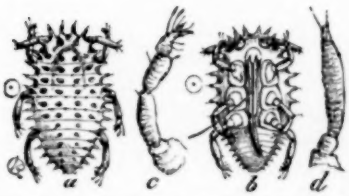
THE AMERICAN OAK PHYLLOXERA (*Phylloxera Rileyi*).—There are several described and undescribed species of Phylloxera in this country, most of them inhabiting leaf-galls made on our different hickories. The species herewith figured is the only external feeder known in America, and it is briefly alluded to in this connection to show that, as with the grape Phylloxera, it does not need a "winter egg" to enable it to hibernate, but passes the winter in the larva state (as at

FIG. 9.



PHYLLOXERA RILEYI.—*a*, pupa; *b*, winged female; *c*, antenna greatly enlarged; *d*, portion of infested leaf.

FIG. 10.



PHYLLOXERA RILEYI.—*a*, *b*, dorsal and ventral views of larva as seen hibernating; *c*, *d*, highly-magnified leg and antenna of same.

Fig. 9), firmly attached to the tender bark of the younger twigs, and thus braving all the vicissitudes and inclemencies of that season. In the summer it is found on the underside of the leaves of our white and post oaks, fixed in the centre of a yellowish spot caused by its puncture, and showing most on the upper surface, so that on a badly-infested tree the leaves all look speckled, and seared, and withered. It presents all the different forms and the same biological characteristics that I have described and detailed of the grape Phylloxera.

CONCLUSION.

We have, in the history of the grape Phylloxera, the singular spectacle of an indigenous American insect being studied, and its workings understood in a foreign land, before its presence in its most injurious form was even suspected in its native home. The Franco-Prussian War, with all its fearful consequences to France, has passed away; the five milliard francs (one thousand million dollars) have been paid, as indemnity to her victors, in so short a time that the civilized world looked on in wonder and astonishment. Yet this little Phylloxera, sent out, doubtless, in small numbers, by some American nurseryman, a few years since, continues its devastating work, and costs that unfortunate country millions of francs annually. The last German has been removed from French soil—at terrible cost, it is true—but the Phylloxera army remains; and, if another five milliard francs

could extirpate the last individual of this liliputian insect-host from her soil, *La belle* France would be cheaply rid of the enemy. Had the world, twenty years ago, possessed the knowledge we at present have of this insect and of its dangerous power, a few francs might have originally stayed its invasion of that great vine-growing and wine-making country. Needs there any more forcible illustration of the importance of economic entomology!

SCIENTIFIC AND INDUSTRIAL EDUCATION IN THE UNITED STATES.[1]

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A LITTLE more than two hundred years ago, in England of the Roundheads and Cavaliers, a voice was raised to propose that young men receive instruction bearing on the various national industries. He who proposed this was a man of great genius—one of the true priests and prophets of his time. He foresaw and foretold many great modern inventions, and among them the steam-engine. His brain helped to think out its principles, his hands helped to shape its groundwork. With pen and tongue he sought to promote the "new education;" but he had fallen on evil times. With Strafford and Laud on one side, and Hampden and Cromwell on the other, there was but poor hearing for the industrial ideas of the Marquis of Worcester. Persecuted, maligned, and a bankrupt, he died, and, to all appearance, his idea died with him. For two centuries afterward Oxford and Cambridge solemnly ground out the old scholastic product in the old scholastic way.

About fifty years ago, a body of the best scholars and thinkers in England made another attempt. Their endeavor was, to found an institution giving an education fitted to the needs of their land and time. They established the University of London. Never had a plan more brilliant advocates. Brougham, Sydney Smith, and Macaulay, spoke and wrote for it; but their success was small. The institution was unsectarian, therefore the Church declared against it as "godless;" it gave instruction in modern learning as well as in ancient learning, therefore the great body of solemn scholars declared it unsound; some of its ideas and methods were new, therefore a multitude of leaders of society declared it unsafe. The institution was kept down, and from that day to this has never taken the high place to which its plan and work entitled it.

[1] An Address delivered before the New York State Agricultural Society, revised by the author for the POPULAR SCIENCE MONTHLY.

About thirty years since, the strongest man who has ever stood in an American college presidency made an effort in the same direction. Francis Wayland knew what there was of good in the old scholarship and was loyal to it, but he saw that new times make new demands, and he planned out and endeavored to work out a system of education which should meet these demands. All to no purpose. It was the old, old story—another great man, with his great idea, as Carlyle phrases it, "trampled under the hoofs of jackasses," or, as Wayland himself phrased it more mildly, "nibbled to death by ducks."

Various minor attempts were made—some of them, like Eaton's noble effort at Troy, very fruitful; but no general plan, no large institution was created worthy of the great interest involved.

About five years later, Mr. Lawrence, of Massachusetts, a thoughtful manufacturer, made another attempt. He saw the necessity of education bearing on the great industries of the country, and made to Harvard College what in those days was called a princely gift. Thus was founded the "Lawrence Scientific School," at Cambridge, and thus did industrial studies get their first foothold in a great university.

About five years later still, Mr. Sheffield, of Connecticut, also a thoughtful business-man, recognized this great necessity. By a generous donation he founded the "Sheffield Scientific School" at Yale College, and thus these studies got foothold at a second great university.

So much, then, was gained. Some few of the studies bearing on the great modern industries had been taken under the care of great university corporations; but there was one drawback. In neither of these universities were the new studies received into full fellowship with the old. The Scientific School was kept very distinct from the "College proper." Buildings, courses, and studies, were kept well apart; the student in the sciences was not considered the equal of the student in "the classics." The student preparing for an industrial profession was not considered as of the same caste with the student preparing for a "learned profession." He lived in a different building, had lectures and recitations in different rooms, was instructed by different professors, was graduated at a different time and place. He was not considered as properly of the graduating class of his year. Ask any Yale or Harvard man for the names of his classmates, and it never occurs to him to mention the graduates of his year from the scientific departments. Nay, whether it was that young men taking scientific studies were considered as *ipso facto* lost souls, or as having no souls to be saved at all, they were not admitted to the students' seats at the college chapel—they were practically held as of an inferior order.

The next step was made at the State University of Michigan. Here, for the first time in a university, a student in general or industrial science was admitted to full equality with a student in classics.

So far as their studies were the same, they sat in the same rooms, heard the same lectures from the same professors, were admitted to the same chapel, received their degrees at the same time and place, went through the same ceremonies, and stood as equals on the roll of graduates.

Still the provision for industrial education was wretchedly meagre. Other nations had meanwhile shot far ahead of our own in this respect. Germany, France, and even England, had been aroused. They had recognized the fact that the greatest warfare of the nineteenth century is industrial warfare—the struggle between great nations for supremacy in the various industries, and for the control of the various markets. France had developed magnificently her system, putting nearly half a million dollars into a collection of models for the School of Arts and Trades alone. Germany had established a multitude of "*Real Schulen*," and of Technical and Agricultural Colleges. England was already making preparations for her great institution at South Kensington, on which she has lavished millions.

But, just as our great rebellion was drawing on, an attempt was made in the Congress of the United States. Years before, that pure and great man, Dr. Channing, had urged that the proceeds of the sales of public lands be consecrated to the education of the people. An attempt was now made; but, though the good sense of Congress carried a bill, it was vetoed by James Buchanan. But the friends of the measure still pressed on. A chorus of optimists, pessimists, sham economists, holdbacks, and do-nothings, opposed the measure; but a true statesman led the army of education. Justin S. Morrill, of Vermont, stood then as now in the United States Senate. Let his name be long remembered. Statues shall be erected to him long after the little great men who tried to thwart him are forgotten. The bill was passed, and it was signed by Abraham Lincoln.

I ask you now to look a moment at the passage of that bill. Centuries hence men shall look back upon it as one of the noblest things in American annals. Why?

My friends, have you forgotten those days, their discouragements, their forebodings, the morning beginning with "would God it were evening," and the evening ending with "would God it were morning?" It was the darkest hour since Valley Forge; lives, laws, family ties, treasure—all seemed cast into the abyss—and the abyss ever growing wider, and deeper, and blacker—and yet, while the American Congress was providing for the most tremendous home policy, and carrying on the most difficult foreign policy of modern times, they found leisure to plan and carry out a great, comprehensive, and far-reaching system of national education.

Gentlemen, it was one of the great glories of Rome in its best days that its statesmen did not despair of the Republic in its blackest hours. Nay, when a victorious Carthaginian army was encamped

on Roman soil, so great was Roman faith in Roman destiny, that the very soil at that moment trampled by enemies' feet was sold at auction and bought by competition. But here was greater faith; here was nobler patriotism. While the windows of the Senate-house were rattling with the enemy's cannon, those men had such faith in the destiny of the nation, and such trust in the arts of peace, that they quietly and firmly legislated into being this great, comprehensive system of industrial and scientific education. In all human annals I know of no more noble utterance of faith in national destiny out from the midst of national calamity.

But what was this measure?

The question is pertinent, and all the more so now, on account of sundry efforts to misrepresent it. Look at the act of Congress itself. You see at once that it did not provide simply for agricultural colleges, nor simply for colleges of the mechanic arts. No; the intention was broader and deeper than that. It provided that "subjects relating to agriculture and the mechanic arts" should be made "leading branches," "without excluding other classical and scientific branches," and including "military tactics."

What, then, was the purpose? It was to provide fully for an industrial, scientific, and general education suited to our land and time —an education in which scientific and industrial studies should be knit into its very core, while other studies should also be provided for. And, besides this, as it had been seen that the States in rebellion had gained great advantage from the military education of students, it was declared that "instruction in military tactics shall also be included."

The act of 1862 was, then, a noble, comprehensive scheme, looking, as you see, first of all, at the industries of the nation, but at the same time insisting on provision for the broadest scientific and general culture.

I pass now to the reception of the benefits of the act by the various States.

Under the law, land-scrip was given the different States, based upon the representation of each State in Congress, scrip for thirty thousand acres being issued for each representative and senator. You will note here, in passing, one more provision showing thoughtful statesmanship. It was provided that, except in the case of States having public lands within their own borders, *no State should "locate" the scrip.* The great majority of the States could not, therefore, obtain *land.* They could only take the scrip and sell it at market prices. An individual might buy the scrip and locate it; a State could not. Thus was prevented any troublesome *imperium in imperio,* such as would have been created, for example, had the State of New York been allowed to acquire a million of acres in the heart of the State of Wisconsin.

The various States accepted the scrip, and in almost all cases sold it at low prices, the market being glutted; and with the proceeds each established its institution under the act as its interests demanded, or as the money realized permitted.

Note now another important fact. Some States—as Connecticut, Rhode Island, and New Jersey, where the fund was too small to establish a separate institution—gave it for the endowment of scientific and industrial education in an existing institution. Connecticut gave her share to Yale, Rhode Island gave hers to Brown, New Jersey gave hers to Rutgers, New Hampshire gave hers to Dartmouth.

States which received a larger share—but still not enough to carry out the act in all its parts—gave theirs to purely agricultural colleges. Of these were Michigan and Iowa. Others, with a larger share, divided theirs between an institution for agricultural and an institution for technical instruction. Of these were Massachusetts and Missouri. A few which received the largest share determined to carry out the act in its whole scope by founding a single institution, in which industrial and scientific education should be united to general instruction and culture. Of these were Illinois and New York.

It may appear to some that this difference in modes of carrying out the act in the different States was a misfortune. Far from it. I am prepared to maintain, against all comers, that, of all the good fortune which has attended the carrying out of the act of 1862, this variety of plans and methods in the various States was the best.

Look at it for a moment. Of all men none has stamped more ideas into the thinking of this generation than has John Stuart Mill; but among all his thoughts regarding education I remember none more pregnant and original than one regarding systems of public education. It is that, with all its benefits, such a system has one great danger, and that is, its tendency to shape all minds by the same course of education into the same mould, thus preventing the fruitful collision and friction of mind with mind; thus bringing on a stagnant, barren sort of Chinese routine in thought.

Happily for us, by leaving these funds to each State for management, this evil has been avoided. And not only this, but almost every one of these institutions has found out something of use to every other. There is, indeed, unity between all, but not uniformity; and here let me say that having made it my business to look closely into the methods of all these institutions, and to visit and personally inspect many, in order to bring home what might be good for our own use, I can bear testimony that never have funds been more carefully applied and made to do more in furthering this great purpose.

I know every one of these institutions, and I know not one which is not making a noble return on all it has received.

No sooner was the bill passed than a multitude of colleges rushed forward to these legislative halls in a scramble for the fund. At one

time there were twenty institutions calling themselves colleges and universities of various religious denominations clamoring at Albany for a scrap of this endowment. As scrip was selling, the whole fund, had not an individual come forward to "locate" it, would have amounted to about $600,000. Dividing this among the twenty, there would not have been enough money to give a single professorship to each.

This the Legislature of New York saw, and, despite the pressure from these institutions, it wisely determined not to fritter away the fund, but to concentrate it. It recognized the fact that for primary education the rule is diffusion of resources, but, for advanced education, concentration, and it wisely concentrated the fund upon an institution known as the People's College, at Havana.

The endowment was given to the People's College on certain conditions. Among them, it was required that the institution should have a certain amount of land, accommodations for a certain number of students, a Faculty of a certain size, a certain equipment, and that it should be free from incumbrance. A year went by, and these conditions were not complied with. Still the Legislature waited, and sturdily refused to yield to clamors for frittering away the fund. Another year went by, and still nothing was done; and, what was worse, it was discovered that a bill had been introduced to relieve the People's College of these conditions. At this, Mr. Ezra Cornell came forward and offered to pledge an endowment of $500,000 to a new institution, provided the funds were transferred to it. A bill was passed chartering such a new institution; but, in order that full justice might be done the People's College, it was allowed three months to put itself in possession of such sum as the Board of Regents of the State should declare equivalent to compliance with the conditions of the original act.

The Regents, after full examination, fixed the sum at less than $170,000. For nearly three years, then, that institution might have obtained the whole endowment had its friends, or had that locality, raised for it a sum of less than $170,000. The time passed—they still did nothing. Mr. Cornell then came forward and redeemed his pledge; and thus was founded, for scientific, industrial, and general education, the Cornell University.

So much for the main features of the struggle toward the establishment of what has been called the "New Education" in the United States and the State of New York.

But what is this new education? I ask you to look first at its special purpose, and finally at its general scope. And, first among the special departments grouping themselves under such a system, I name the COLLEGE OF AGRICULTURE.

And here let me refer to a misapprehension, which should be corrected at the outset. For a typical example of this, I take up a paper read at the recent Educational Convention at Elmira, by the Rev. Dr.

McCosh, President of Princeton College. In that paper, the whole national and State policy regarding scientific and industrial education was condemned. The decision arrived at by two different Congresses of the United States, and by nearly thirty State Legislatures, the plan adopted by nearly thirty Boards of Trustees and Faculties in the various States—many of them after careful study of institutions at home and abroad—were dismissed with contempt. The main argument was, so far as argument can be detected among the multitude of assertions, that Scotland, from which the doctor had not long before emigrated, had got along well enough without any provision for agricultural instruction.

Never was there a more admirable illustration of the thoughts put forth by James Russell Lowell, on "a certain condescension in foreigners." To two institutions the doctor paid his respects by name, one being Rutgers College, in New Jersey; the other Cornell University. The first of these, Rutgers College, it would appear had committed an unpardonable sin. While the doctor's learned predecessors, at Princeton, had been preaching against "science falsely so called," the Rutgers College authorities had received that portion of the college land-grant fund which came to New Jersey, and had established an admirable school for applied science. This it was, doubtless, which led the doctor, in the heart of this State of ours which glories in its descent from the men who founded the Dutch Republic, to stigmatize his sister institution in New Jersey as "managed by a pack of Dutchmen."

His reference to the Cornell University was of another character, and not all my respect for the doctor's ability as a metaphysician will allow me here to suppress the fact that his whole argument was based upon one of the most astounding misrepresentations ever attempted upon an American audience.

This misrepresentation was in regard to the law of Congress of 1862. Throughout the doctor's address the idea is conveyed that the law of 1862 contemplated solely the establishment of exclusively agricultural colleges.

Nothing could be more wide of the fact. Had the doctor ever read that law he would have seen that, while "subjects relating to agriculture and the mechanic arts" were named as "leading branches," it was expressly declared in the act that other scientific and classical branches should not be excluded. Nay, more, he would have seen that so broad was the intention of Congress that the wording of the act is, that "subjects *relating* to agriculture and the mechanic arts" shall be taught, thus giving the authorities permission to extend their teaching into every field of learning which could strengthen these departments or elevate them.

I am aware that, in opposition to the plain intent of the act of 1862, the doctor may fall back upon its title, in which, for the sake of

brevity, only the leading objects of the colleges are mentioned; but, had he read even so accessible an exposition of law as Kent's "Commentaries," he would have found that every act is to be construed by its contents and not by its title.

But the doctor was especially hilarious over the small number of graduates from our agricultural colleges.

Let us look at this. The number is at present very small, but I presume that no thoughtful man expected that at so early a period after their establishment the number would be very large, nor, indeed, do I expect that for some years the number will greatly increase. In a new country like ours, those professions which present the most brilliant returns will be sought for first. Hence we find that, when a farmer decides to educate his son, it is not generally with the idea of making him a farmer. And, even when he does bring him up as a farmer, he has great doubts as to the value of any instruction for that purpose outside of the old farm routine.

But while I allow freely that this is the case now, I can state quite as confidently that this condition of things cannot continue for many years. There are those now living among us who will stand among a hundred millions of citizens within the boundaries of our Republic. When that day comes—nay, long before—this present condition of things must change. The present system of routine cultivation—this present system of "skinning" lands and then running away to soils more fruitful, in the intention of robbing and running away from them in turn—cannot last. Men must get a subsistence on less and less land; and they can only get it by bringing to bear upon it better and better cultivation. How soon we shall come to the division of property in the Scotch Lothians or the Belgian Pays de Waes, with their small farms exquisitely tilled, and supporting well a body of thrifty men, I cannot say; but the steady approximation to it is as inevitable as fate. And at the same time that this goes on, the professions hitherto known as "learned" will be more and more thoroughly filled. We see the beginnings of this now. Already is it becoming less and less easy for the farmer's boy to be sure that the little dark office in the great city block, swarming with lawyers, is, after all, so much more promising than the open fields and the work of the farmer.

And now, what should this industrial education be? Many men, hastily looking over the subject, have jumped to the conclusion that it should consist in simply teaching the plain arts of husbandry and of mechanics; that is, that the great object should be to train young men simply or mainly to hoe or spade or plough in the fields, or to make chairs or shoes, or hats or boats, in the shops. There could be no more wretched perversion of the trust imposed by Congress. The phraseology of the act of 1862 was chosen with great care, and, when it speaks of "branches *relating* to agriculture and the mechanic arts," it means just what it says. It meant to provide that all applicable

science be brought to bear on those arts. It meant to provide for the education of men who could develop them and improve them. Merely to add, to the millions now intelligently practising these arts, a few more intelligent farmers or artisans each year, would be a wretchedly inadequate return for these endowments. The places for imparting the simple, usual practical education for agricultural and mechanical pursuits are the millions of farms and workshops in the country. Nowhere else can such practical knowledge be afforded so cheaply or so effectively.

The national institutions for education should, indeed, have farms and workshops; but the foremost object of these should be, not to afford simple employment to young men, but to give them, in connection with their studies in the sciences, what may be called *laboratories*, where they can see science applied in as practical a manner as possible —laboratories, whether field or shop, where they can see sciences limited by the necessities of practice. It cannot be too much insisted upon that the main object of these institutions should be to send out men, with minds trained by observation and experiment, to develop the various agricultural and other industries, and to improve them, and not simply to increase, by an almost infinitesimal fraction, the number of those engaged in the usual industries pursued with a little more intelligence, in the usual way.

But it is said that scientific and industrial education does not better agriculture. Does it not? Of all assertions this is the most fearful indictment against the most extended field of human thought and work. If this be true, then is agriculture the only industrial pursuit unworthy of a human being; for this assertion would not be made against any other branch of human industry. But it is not true. The whole history of agriculture shows exactly the reverse of this. Look at those wonderful "Tables in Comparative Sociology," by Herbert Spencer, just issued, and study there the progress of agriculture and other industries from their rudest beginnings, and you see that skill in observation and reasoning on observation have been steadily improving agriculture, at the same time that they have improved other industries.

But grant that the number of students devoted wholly to agriculture is small, it is not these alone whose education tells upon agriculture. Even a partial course in it has great value. It was the remark of a very distinguished statesman of this Commonwealth—one who occupied this desk as Speaker, yonder chamber as Governor, and who received the suffrages of many of his countrymen for the highest office in their gift—that the main thing in agricultural education is to do something to make agricultural pursuits attractive. His view is that whereas in England every man longs to obtain a competency to enable him to retire from the city, here men seek to escape from the country to the city; and that we should attempt to bring about a change of

this sentiment in our educated young men. The author of that remark is Horatio Seymour. It struck me powerfully as sound and just, and, shortly after the establishment of the Cornell University, the trustees adopted a rule by which every student in every department—as a condition for graduation—must hear a course of lectures on general agriculture.

I am glad to state that, although the rule was received with some grumbling at first, that grumbling stopped immediately after the first lecture. Said a student to me at that time, "These lectures make us all wish to get hoes, and go at scratching up the ground at once." The lecturer for this general purpose is John Stanton Gould. May his interruption by ill health, which has deprived us of his service the past year, be but temporary! Long may he be spared to the University and the State, for whose good he has so steadily and so earnestly labored!

But suppose that no young men came forward to take agricultural studies, the new education would still tell powerfully on agriculture. Think you that we can send out year after year—as we did last year—a hundred graduates from all our various departments, whose powers of observation have been trained and whose real knowledge of subjects bearing on agriculture has been extended by close study in Botany, Animal Physiology, Geology, and Chemistry, without its telling ultimately on the progress of agriculture?

But suppose that not one student was even thus educated, I maintain that the State and nation would receive more than the equivalent of its endowment.

Look at a few figures. The last census gives certain agricultural statistics whose magnitude is almost oppressive. The value of farm productions in the United States, in the year 1870, was considerably over $2,000,000,000.

The value of farm productions in the State of New York, the same year, was over $250,000,000.

Does not common-sense tell us that we can well afford to make a little outlay to promote any sciences which may help such a vast interest? If in the course of years, in all these laboratories and experiments, some one useful idea shall be struck out, it would repay our endowments a thousand-fold.

Says Emerson, "The true poet is an inspired prophet." Did you ever think what an inspiration lies in the poet's declaration that "the greatest benefactor of mankind is he who makes two blades of grass grow where one grew before?" If not, look at the census returns showing the enormous value of the hay-crop of these Northern States.

Knowledge of Nature—coming by research and observation in the laboratory and the field—these are to give us finally our "two blades of grass," and multitudes of other benefactions to our race not less precious.

The Sheffield Scientific School at Yale College has not a single stu-

dent in agriculture, but Profs. Brewer and Johnson, by their experiments on fertilizers and kindred subjects, have returned the value of their endowment to the nation a hundred-fold already.

Take another item. The dairy products of New York in 1870 were over 100,000,000 pounds of butter, and over 20,000,000 pounds of cheese. Now, there has been quietly at work, in our Laboratory of Agricultural Chemistry at Cornell University, a young professor, Mr. George C. Caldwell. He has made little noise in the world. While Dr. McCosh was striking the stars with his lofty head, and his voice was shaking the Agricultural Colleges, this young man worked quietly on upon the chemistry of the dairy. Said Mr. L. B. Arnold, an authority you all recognize, "Prof. Caldwell's researches on the chemistry of the dairy are worth more to the State than your whole endowment. He has taught us to do such things in dairy matters and to increase dairy products as we never dreamed of doing." And to this, substantially, Mr. Arnold has lately sworn before the Commission of Investigation.

Take a few figures more from the same census. In 1870 the market-garden and orchard products of the State of New York amounted in value to close upon $12,000,000.

Can any one, then, gainsay the wisdom of our employing, as we do, a young naturalist of genius to devote his whole time to investigations regarding insects injurious to vegetation, and to giving lectures based upon these researches?

Take still other figures. The same census shows the value of farm implements in the State of New York to be over $45,000,000. In view of this we have investigations and lectures upon mechanics related to agriculture, and have obtained models and implements at home and abroad to illustrate this subject. Is not the mere pittance this requires well laid out?

I remember some years since seeing a paragraph going the rounds of the papers, stating that President White had sent from Europe to Cornell University an Oxford professor and a horse-doctor. The charge was true. The Oxford professor was Goldwin Smith; "the horse-doctor" was Prof. James Law, formerly of the Royal Veterinary College at London. Each one of these men, in his way, has been a blessing to the University and to the country. But look at a few more figures from the census. The number of horses in the State of New York is over 800,000; the number of neat-cattle exceeds 2,000,000. Prof. Law's lecture-room is one of the most attractive places I know, for animal physiology is a study worthy of any man, but, even if he never taught a student, in view of this vast interest is it not well worth while to provide such a man to investigate such a subject?

Take another branch. We have been fitting up an establishment for experiments in the best rotation of crops and in the feeding of cattle. A careful and resident professor has been called to carry on

these, and I trust that Mr. E. W. Stewart may be called to superintend them.

Some time since, in view of this matter, I visited certain cattle-feeding establishments with a gentleman whose sound sense on such matters you all recognize, Hon. George Geddes. Said he: "This experiment, fairly tried, will be worth to the State of New York more than your whole endowment, no matter which way it turns out—no matter whether 'soiling' is found profitable or unprofitable; to try this matter fully, and fairly, and scientifically, will be worth more than your endowment."

The act of 1862 also provides with special care for instruction in "BRANCHES RELATING TO THE MECHANIC ARTS."

If you doubt the wisdom of this, look again at the last census. There you find the manufactures of the United States valued at $4,000,000,000, and over 2,000,000 persons engaged in them. Can education be made useful to this vast interest? Other nations think so, and are laying out vast sums in this direction. Some of our sister States are doing admirably in this respect. Illinois and Massachusetts have made excellent provision for mechanical science, and the recent message of Governor Bagby, of Michigan, shows that good work is to be done in that State. In an address delivered before this Society a few years since I described some of those foreign institutions. I trust, then, that you will pardon me for describing that which we have since created in this State.

Thanks to one of our trustees, a noble provision has been added for this purpose to that originally made by the nation.

The Hon. Hiram Sibley, of Rochester, has erected a building, equipped it with lecture-rooms, draughting-rooms, a workshop supplied with the best machinery, and has given an endowment to support a Professor of Mechanical Engineering and a superintendent of the machine-shop. Besides this, Mr. Cornell has erected a shop for wood-working, and has provided water-power for both establishments.

What is the system? Young men come wishing to make themselves first-class mechanical engineers or master-mechanics, or to perfect themselves in any branch of mechanical industry. Under careful instructors, they are carried through the various sciences bearing on their profession. They are taught mathematics in all their relations to mechanics. In one room they go on with the mathematical and mechanical drawing of machinery, in another with free-hand drawing; in the laboratory they are taken through various processes bearing upon their profession. A certain number of hours every day they must give to the workshop, and there, in well-worn apron and rolled-up sleeves, they go on under careful supervision from the use of the simplest machinery and the plainest work to the most complicated. The purpose is to send out every year a body of young men with not merely a very high grade of theoretical instruction, but with most thorough

practical instruction—men who cannot merely calculate the size of parts of a machine, but who can draw it after they have calculated it, and make it after they have drawn it. These are the men whom our country sorely needs to complete the organization of its great army of industry. Indeed, I know of no more pressing material need in this country. Our land has more mechanical ingenuity in it than any other; but did you ever think of its wretched misdirection and waste for want of industrial education? If not, stroll through the national Patent-Office. Look at a few facts. In one of our most important cities are engines for supplying that city with water—erected at vast expense. The whole amount was wasted. There is ingenuity in that vast machine, there is skill in it; but, for want of education regarding certain principles involved, the whole thing is failure and waste.

Take another case. A few years since, with a small party of our fellow-citizens, I visited the West Indies in a national ship. She was a noble vessel, and her engines had cost, it is said, nearly $800,000. The engines showed ingenuity; but they were so deficient in proper elements of construction that our voyage was prolonged until we were all given up as lost and had the honor of having our obituaries in the leading newspapers! The first voyage of those engines was the last. They were sold for old iron; and the sum lost on them alone was sufficient to endow the finest institution for mechanical engineering in the world! I might multiply examples of this sort, but this is enough to show what need exists for more careful training in this direction, and I pass to a kindred department.

Another great department bearing on a multitude of industries, directly and indirectly, is CIVIL ENGINEERING. Take one among the fields of its activity. We have in the United States about seventy thousand miles of railway, and every year thousands of miles are added. I do not at all exaggerate when I say that millions on millions of dollars are lost every year by the employment of half-educated engineers. Proofs of this meet you on every side. Lines in wrong positions, bad grades and curves, tunnels cut and bridges built which might be avoided. All of us know the story.

But this is not all. Hardly a community which has not some story to tell of great losses entailed by bad engineering in other directions. I have known the traffic of a great city street interrupted for a year, because no engineer could be found able to make the calculations for a "skew arch" bridge, a thing which any graduate of a well-equipped department of engineering can do. I have known a city subjected to enormous loss by the failure of its water-supply system, because the engineer employed made no calculation for the friction of water in the pipes. I know a whole district sickened by miasma, because a half-taught engineer was intrusted with its drainage. We must prepare men for better work; and, for every dollar thus laid out, we shall create or save thousands.

Take next, then, SANITARY ENGINEERING. Science has, within a few years, made wonderful strides in revealing the origin and propagation of disease. The summaries recently made by President Barnard, Prof. Dalton, and Prof. Chandler, give an admirable view of this conquest. Mr. Baldwin Latham, in his recent book on "Sanitary Engineering," gives careful tables, showing the enormous reduction of consumption, typhus, and typhoid, in several English towns by the application of science to sewerage and water-supply. Dr. Beale, in his work on "Disease-Germs," shows by statistics that a proper application of engineering to sewerage would save 100,000 lives yearly in Great Britain. More and more is this matter becoming important in this country. Hardly one in twenty of our towns has any well-adjusted system of sewerage or water-supply, and in our rural districts vast tracts are made wretched by miasma.

Nor is this probably the worst. Vicious systems of heating and ventilation are probably doing more to break down the physical constitution of our people than all other causes combined. We see it everywhere in sickly women, and puny children, and men but half alive. The study of human physiology and the system of preventing and removing disease-germs should be combined, and young men should have the opportunity to fit themselves for grappling with the problems presented to sanitary engineers.

Few among us dream of the monstrous waste now entailed upon this country by imperfect instruction in MINING ENGINEERING and metallurgy. Take first the losses by fraud. A few years since our people were asked to invest in a Nevada mine of great richness. Half-educated mining geologists had certified to its value. But certain capitalists sent a young man, carefully educated in a scientific school, to examine and report. The young man on arriving found that the mine looked well enough, but on applying more scientific tests he found that an old worthless mine had been taken; that rich sulphurets had been brought and carefully placed in it at a cost of probably $100,000. His report exploded the fraud, and nearly $1,000,000 was saved—more than five times the sum that this scientific school received from the Government of the United States. This same gentleman also exploded a great diamond-mine fraud of the same sort.

Take another case. Not long since a party of gentlemen determined to invest several hundred thousand dollars in working certain iron-mines in this State. Just before their arrangements were finally made, and much against the will of many of the proposed stock-holders, a young graduate of one of the scientific schools which received the national endowment was sent to make an examination. He found that the veins contained titanium, and that the entire investment, should it be made, would be lost. His fee was $250; he prevented a loss of over $400,000.

You see now why Pennsylvania and Missouri and California and

Massachusetts are aroused as to this matter also, but you will perhaps say that New York is but little interested here. Look again at the census, and you will see how wretchedly you are mistaken. The value of the mining products in New York in 1870 was more than half that of the entire gold product of California. Here, too, we must follow up the good work begun by our Chandlers and Raymonds.

Look next at CHEMISTRY APPLIED TO MANUFACTURES. More and more the chemical laboratory is becoming a great central point in industrial education. Run over but two or three points out of many. A chemical discovery in coloring-matter has given us a substitute for madder, and restored the great area given to cultivation of that material to the increase of material for human sustenance. An apparently trivial application of another chemical principle has enabled Onondaga to purify its product so that it now competes with the world in the purity of its salt for the dairy. Another application has enabled another part of the State to make quantities of steel formerly undreamed of. And all this is but the beginning of the applications of chemistry to increase the well-being of the State and nation.

We must also make provision for instruction in ARCHITECTURE. Wealth and public spirit—individual and municipal—are now erecting myriads of costly buildings in all parts of our country. The number of uneducated architects is very great—the number of thoroughly prepared architects is very small. Have you ever considered the waste attendant upon this? Every month you hear of some architectural failure that costs life and treasure. To-day it is a church-floor which gives way, and a multitude of children are taken from the ruins mangled and dead; to-morrow it is a whole city quarter swept away by fire, because some half-taught architects knew no other way of producing architectural effect than by piling up combustible ornaments on inaccessible roofs.

Nor is that all. Our people are laying out millions on millions in buildings which within thirty years—in the advance of taste and knowledge—will be eye-sores and must come down. A building erected by a true architect will grow more beautiful for hundreds of years. A building erected by a sham architect will be an incubus in a quarter of a century. People are beginning to see this, and we are endeavoring to prepare men thoroughly to know the best materials, to calculate their strength in construction, and to combine material and construction according to everlasting laws, and not according to some pretty present fashion; and this is the purpose of our School of Architecture.

Look now at instruction in DRAWING. The casual visitor to an institution like that established in this State will often say something like this: "I can understand the value of your libraries, collections in natural history, apparatus, models, shops, and lecture-rooms; but what is the use of your great draughting-rooms?"

If I answer that drawing is taught in one for civil engineers; in another for mechanical engineers; in another for architects; in another free-hand drawing for all these together, he will say: "Why teach free-hand drawing at all? That is rather artistic than industrial."

Is it? Look at a few recents facts. A few years since the State of Massachusetts passed a law requiring free-hand drawing to be provided for in the public-school system throughout the State. The city of Boston did the same. State and city combined to call, from the great English school for industrial art at South Kensington, Mr. Walter Smith, at a salary of $5,000, to direct the schools of that city and State.

Mr. Smith has worked on, and the result is that already this instruction has been admirably developed. Now, why has this been done? Has the State of Massachusetts, which we have always known as so thoughful in its legislation and education, really fallen into mere dilettanteism? Not at all. Look at a few more figures from the census.

In 1870 the product of Massachusetts in printed cottons was over $17,000,000, and her product of other goods into which the arts of design enter as a matter of first importance was doubtless even more. Massachusetts is thoughtful as ever. She sees that other States are overtaking her in manufactures so far as quantity and quality of material are concerned, but she determines to distance them by spreading throughout her borders knowledge of the principles of beauty in design and skill in them. And she never did a wiser thing. It will tell on a multitude of industries. Why do we import such vast quantities of English, German, and Danish glassware and pottery?—because they are better in material than ours? No; but because they have a beauty in design which leads the most illiterate to choose them. Why do we import such quantities of silks and carpets and chintzes and wall-papers from France? The Cheneys make silks as good in quality on this side of the ocean as the Compagnie Lyonnaise make on the other; the Bigelows make carpets just as good in material here as the D'Aubusson factory makes there; and yet, when our wives and daughters see these foreign fabrics, they immediately prefer them. Why? Simply because there generally are in the foreign product a skill, a beauty, a taste in design, that appeal to that sense of beauty which God has implanted in the rudest of our race.

Other nations in this warfare of industry see this. England is devoting millions to art education, in order to keep up her manufactures, and it has established in the Privy Council a science and art section to direct this expenditure wisely; Germany is doing even more; France has been doing it for generations, and it has given her the supremacy thus far in a multitude of branches of manufacture.

If you wish to see how these nations have done and are doing this, look at Mr. Stetson's admirable little book on "Technical Education."

You will there see that Prussia alone gives industrial education in various branches to over 11,000 men. If you wish to see how public-spirited individuals have done this, visit the draughting-rooms of the Cooper Institute, and Worcester Institute, and Lafayette College.

Already the value of this is known to our manufacturers. Mr. Stebbins tells us that one silver-ware establishment in the city of New York pays a graduate of one of these foreign schools, for making designs and patterns, as high a salary as our Empire State gives its Governor.

But it may be said, "The French are naturally artistic; our people are not." But, look at history; see how it disposes of these short and easy excuses for doing nothing. The French are descended, on one side, from the most unartistic nation of antiquity, and on the other from painted barbarians. As to the former, one of their greatest poets boasted that his fellow-Romans could tyrannize over the world, but had no capacity for art. As to the latter, Guizot, one of the greatest of statesmen and historians, shows that the barbarian ancestors of the French had the same fundamental ideas as American savages.

When our ancestors were savages, their ancestors were savages. It is only a few generations since, if they wished for good artistic work, they had to send to Italy for it. The French are "naturally artistic" because Liancourt, and other patriots like him, began, a hundred years ago, to create those great systems of education—scientific, industrial, and artistic—which have given the French almost the monopoly in supplying products of skill and beauty to the markets of the whole world.

To complete the system provided by the great congressional act of 1862, it was declared that instruction in MILITARY TACTICS shall also be included.

Not least among the evidences of statesmanship in that bill was this last clause. The idea it embodies has been too long neglected. Of all fatal things for a republic, the most fatal is to have its educated men in various professions so educated that, in any civil commotion, they must cower in corners, and relinquish the control of armed force to communists and demagogues. The national colleges have carried out this part of the act, sometimes by giving advanced military instruction, but generally by careful drilling of the whole body of students. The system has been found to give health and manly dignity to the student; to the nation it is to give a great body of well-trained men, ready to organize and control the best elements of society against any outbreak of anarchy or treason.

And now a few words regarding the general education which goes with these various branches of industrial and scientific education. The student must be not only trained as a specialist, he must also be educated as a man and a citizen. Hence the necessity of blending into the various special courses certain general studies calculated to

give breadth and foresight and insight. Among these I name, first, instruction in HISTORY AND POLITICAL SCIENCE.

On this subject, the "new education" lays stress, and especially on the history of our own race and country. The subject has been sadly neglected; but more and more it is seen that, to train men to build up the future, we must show them with what successes and failures their predecessors have built up the past.

Thought, too, should be stirred on the more pressing problems in SOCIAL SCIENCE, and among them the best methods of dealing with pauperism, crime, insanity, sanitary management, and public instruction. Foundations for study on these might, at least, be laid, and right direction given to those whose tastes turn toward participation in public affairs.

No thoughtful man will deny that it is well to give even to students in industrial branches access to the best thoughts of the best thinkers —the study of the great languages and LITERATURE does this—and especially is it done by the study of this wonderful language and literature of our own.

Another most important means of discipline and culture is to be found in the study of THE NATURAL SCIENCES. On these much of industrial and general progress depends. They discipline the power of observation, and reasoning upon observation. They give, too, a culture to the sense of beauty in form, and fitness in adaptation.

But I am aware that objection is made to the study of Natural Science on the ground of a dangerous materialistic tendency.

But can this objection be well founded? Among the many striking passages in Herbert Spencer's "Treatise on Education" is one of special interest on this point. He asks, what would any author think were a person to come into his presence, praise his works, and dwell upon their beauty and perfection, when the author knew that this flatterer had never read a single page, or even a single line, of them? And what, then, must the Great Author of all things think of one who thus comes into his presence, extols his works in all moods and tenses, the Great Author knowing that this flatterer has never studied out a line in the great book of Nature—nay, that he has discouraged others from studying it? I come now to certain GUIDING IDEAS—necessary in carrying out any worthy system of scientific and industrial education.

1. Of these I name UNSECTARIANISM. Our own charter makes "men of all sects and parties, and of no sect or party, equally eligible to all offices and appointments." For this, some good men have thought it their duty to denounce us from pulpit and press as "godless;" but it has proved our salvation. It has enlisted benefactors of every creed. That it has taken strong hold upon the people is shown by the millions given the institutions on this basis, and by the steady support of these despite all calumnies. There is no other possible basis for the development of great institutions for scientific and indus-

trial education. To confine their choice of professors to any one denomination, or circle of denominations, is to dwarf them; to put them under control of any synod, conference, association, council, or convention, is to strangle them.

2. I name FREEDOM OF CHOICE BETWEEN VARIOUS COURSES OF STUDY. The old way in the more venerable colleges and universities was, to force all students through one single classical course—the same for all. This system the "new education" discards. General courses in literature, science, and arts, are presented, as well as special courses having reference to the great industries; and the student, with the advice of friends and instructors, takes that which best suits the bent of his mind. We believe that the results are already better than those of the old system. Certainly they could not be worse. The famous "Blue-Book of the Parliamentary Commission" on advanced education, in England, shows that under the old system there seventy per cent. of the students in their great schools and universities take no real hold upon classical studies. Few will claim that our system of classical instruction is better than that in England. If any of you think it more promising, look at President Barnard's cogent statistics on this point. We make no opposition to classical instruction. We agree that, for those who take earnest hold of it, it is one of the noblest means of discipline and culture; but it is no less evident that for those who do not take hold of it—who merely "drone" over it—it is one of the worst.

3. I name EQUALITY IN POSITION AND PRIVILEGE BETWEEN DIFFERENT COURSES OF STUDY. I have already shown how courses of study in science, and especially those bearing on industry, have been held, in various places, virtually inferior to courses of study in literature. Against this we stand pledged. We are determined to hold all courses and all students as equal; educating them together, graduating them together, welcoming them back as alumni together. But the "new education" does not merely endeavor to give a greater range of studies, it seeks also to improve METHODS. Let me mention two of these:

1. I name the BETTER USE OF THE LECTURE SYSTEM. Those who knew Louis Agassiz well will never be at a loss to recall conversations, instructive and entertaining; but I think that, among them all, none conveyed a better mixture of philosophy and fun than his delineation of the recitation of text-books by rote, as it has been so long practised in our American colleges. No system was ever better calculated to deaden enthusiasm and stiffen knowledge. More and more we are coming to see that, wherever possible, we must bring the living mind to bear on the student. Thus may we supplement text-books, and take from them their present woodenness and dreariness.

2. I name THE UNION OF STUDY OF THINGS WITH STUDY ABOUT THINGS. Under the old system it was book in the morning, book in

the afternoon, book in the evening—an unceasing round of studying what men have said *about* things. Under the better system of the various institutions for scientific and industrial education, the student passes frequently from study about things to study of the things themselves, in laboratory or workshop, in draughting-room or museum, or in the field. Every science must now have its laboratory practice, and thereby are given to lectures and recitations reality and interest. Thereby is gained ability to bring theory to bear upon practice.

But an objection of another sort is raised. It is said, "Why give instruction in classical branches at all?" I answer, for three reasons: 1. Because the act of Congress declares expressly that they shall not be excluded. 2. Because to those who wish them they are an excellent means of culture. 3. Because we wish to avoid that old mistake of separating industrial and scientific students from classical students. Heretofore students in science and technology have been banished to some little special college in some remote corner of a town or State, while classical students have had all the prestige arising from connection with large and thoroughly equipped institutions. We stand upon the principle of considering one student the equal of another—the student in science and industry the equal of the student in classics. We stand against any separation which shall serve to perpetuate that old subordination of men in the new education to men in the old.

But it is objected that the new system does not provide for mental discipline. Never was a charge more absurd. Discipline comes by studies that take hold of a man, and of which he takes hold. Is it not evident that the new system, which adapts studies to the tastes and aims of men, is more sure to take hold and be taken hold of than the old system, which grinds all alike through the same processes and studies?

But it is said, "Why concentrate your resources in one institution?" I answer, because that is the only way in which you can ever have the work done. To erect, equip and maintain laboratories, workshops, farms, collections, libraries, observatories—all this demands great sums.

To have such institutions, you must pay the price. While the rule, as already stated, regarding preliminary public instruction, is to distribute resources, the rule in regard to advanced education—scientific, general, or industrial—is to concentrate resources. Look at it. The last report of the Bureau of Education shows in the United States 397 institutions called colleges or universities, and you can count on the fingers of your hands all those worthy of either name.

Wisely, then, have the great States refused to yield to clamors for scattering or frittering away these funds. Wisely have individuals poured out their wealth to supplement them.

To the institution in our own State already over $1,500,000 have been given by individuals, and I trust that this is but a beginning.

Do you say that this endowment may be too large? Compare the endowment for the increase of intellectual wealth with any one of a thousand endowments for the increase of material wealth. Look at the hotels of your great cities. Some of them have cost more than the entire outlay in buildings for advanced instruction throughout whole States.

But it may be said, "Why not devote all your resources to agricultural experiments and instruction?" I answer—1. The law of the United States does not allow it. 2. Because in the interest of agriculture itself we should educate men to develop other industries. What is the great want of our Western States at this moment? Greater agricultural production? No. What they want is, the development of great and varied manufacturing industries, so near them that it shall no longer take two-thirds of a bushel of corn to carry the other third from producer to consumer.

And, finally, it is objected to the "new education" that it is godless. There is nothing new in this charge. It has been made against every great step in the progress of science or education. And yet it has certainly been found that although ideas of religion are changed from age to age, the change has tended constantly to make these religious ideas purer and nobler. The majority of the Fathers of the Church held the new idea of the rotundity of the earth incompatible with salvation. Martin Luther thought Copernicus a blasphemer for his new idea that the earth revolves about the sun, and not the sun about the earth. Dean Cockburn declared the new science of Geology a study invented by the devil, and unlawful for Christians. When John Reuchlin and his compeers urged the substitution of studies in the classics for studies in the mediæval scholastic philosophy, their books were burned, and they themselves narrowly escaped the same fate.

No, my friends; every study which tends to improve the industry of mankind makes a man nobler and better. Every study which gives man to know more of the history of his race, gives him to see more and more clearly the finger of Providence in history; every study which brings his mind into contact with the thoughts of inspired men as exhibited in our literatures, builds up his manliness and his godliness, and every study which brings him into close contact with Nature in any of its fields not less surely lifts him "through Nature up to Nature's God."

I have thus sketched very meagrely the growth thus far of the "new education." Its roots are firm, for they take fast hold upon the strongest material necessities of our land; its trunk is thrifty, for it is fed by the most vitalizing currents of thought which sweep through our time; nay, the very blasts of opposition to this growth have but strengthened it; the winter of discontent through which it has passed has but toughened it; and in agriculture and every branch

of industry; in every science and art which ministers to either; in all the development of human thought which is to make men better and braver, it is to bear a rich fruitage for the State, for the nation, and for mankind.

ABOUT CRABS.

By Rev. SAMUEL LOCKWOOD, Ph. D.

WITH one's eyes kept open, how very much there is to excite interest in a summer stroll beside the sea! Marine life—the creatures that represent the life-zone that belts or fringes the great murmuring world of waters—is so peculiar, some exquisitely beautiful, as the sea anemones, others droll and grotesque, as the great class known as the Crustacea. The tide is out. See that bird with bill curving upward. A beautiful functional adaptation it is—for with it small stones are turned over so deftly, and thus its food, the sheltered worms, are exposed. It is the avocet. So we turn avocet, using a stick in the operation. Ah! we have disturbed a poor polydactyled refugee in his retreat. See how threateningly he snaps at us his two pairs of pincers like formidable blacksmith-tongs. What a crusty-looking fellow he is! Now he is off, running sidewise; for they can go "forward, backward, and oblique." There is speed enough, but the gait is so comical. But crabs are given to flank-movements. We determine to try one on him; so with the stick just touching him laterally, and a fillip, and he is on his back. At this point, Frank, who is always facetious, and who had just been saying that he had come from the Bowling Green (he meant Alley), says, we have knocked the poor fellow off his pins—and that it was a ten-strike, adding for our enlightenment, "Don't you see that crab stands on ten pins?" Now, it so happens in this connection that it is just on this "ten-pin" arrangement that the naturalist founds his division *Decapoda*, as one of the three orders of the great class *Crustacea*. The decapods, or ten-footed, include the crabs and lobsters, and rank the highest in their class.

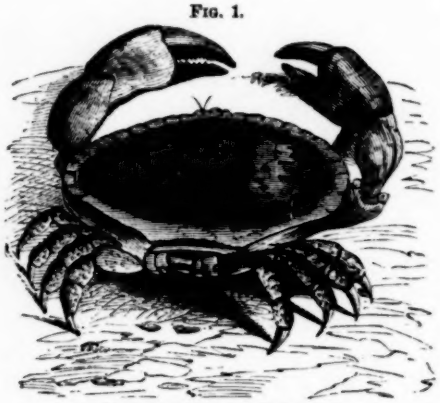
Those who cater to high-living are now announcing the arrival of "Soft-shell Crabs." We propose to give a succinct account of four of our commonest crabs, and shall in passing take note of these "soft shells."

An artist once made a picture of a child; a gay, graceful, romping, and petulant little one it was. It was years afterward, in another place, that he limned a youth, lovable and full of life. And it was long after this, and in some other place, that he painted the portrait of a full-grown man, with a countenance staid, stern, and uncompanionable. Although the artist did not then know it, the three paint-

ings were of the same individual—it was simply the childhood, youth, and manhood, of one person. Many years ago the naturalist described a little crustacean which was noticed swimming gayly and briskly in the sea. It was a pert little thing, rather pretty, and very quaint. It had large, full eyes. In fact, they were enormously so for such a diminutive being. Between these great optics, projecting downward like the coulter of a plough, was a long, sharp spine. On each side of the body was a much shorter spine, and over this short spine on each side, and high up near the back, were two fan-like structures, almost suggestive of wings, as with these four it really sped its way through the water. Between these, and from its back, rose by far the longest spine, almost equal to its entire self in length. It was immensely long, yet delicate and sharp. This *outré* little thing received the name *Zoëa pelagica*. In rank it was considered an entomostracan, the lowest, the very *pariah* of the race. The naturalists also found another little crustacean, something larger, and not so testy-looking either. It had not the formidable spines, but it had feet on the abdomen, which Zoe had not. There were also other great differences. It had, however, like Zoe, large eyes; and so the systematists named it *Megalops*. Well, just here the joke comes in, if indeed we may suppose a joke possible in so serious a science as zoology, especially in the department of the crabs. But the fact was that Zoe, and Megalops, and Cancer, were but the childhood, youth, and adult stages of the same individual, namely, the crab. Now, as Cancer by common consent belongs rightly to the highest crustacean rank—that is, the decapods—so do Zoëa and Megalops.

The common edible crab of Europe has for its scientific name

Fig. 1.



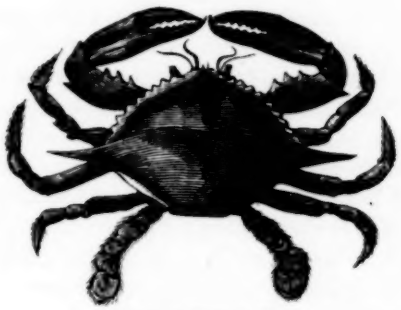
Common Crab of Europe.

Cancer pagurus. It is a much more massive crab than our edible crabs; individuals have been known to weigh twelve pounds each! Let the reader compare the cut of the European crab, Fig. 1, with that

of the American edible crab (*Lupa dicantha*), Fig. 2. It will be noticed that our species has a sharp, spiny extension each side of the carapace, and a pair of oar-like, swimming legs behind. It is a much more active animal.

All crustaceans exuviate, or cast their hard, shelly covering at least once a year. It has been said quite graphically that "the new integument is so soft and yielding, and the muscles in such a flaccid condition, that the limbs are drawn through the small openings at the

FIG. 2.



AMERICAN EDIBLE CRAB.

joints, much as a sack nearly filled with some fluid may be drawn through an opening much smaller than the sack itself." It should not be forgotten, however, that the neck in the great claws, or nippers, is crossed by thin, knife-like blades, or plates of shell; and it is certain that in drawing out the thumbs they are cut into long shreds, which doubtless, when drawn out, come together immediately and heal.

As giving a peep at the private life of the European crabs, let us skim off the cream of a paragraph from Gosse. The naturalist has been exploring the rocks on the English coast, and says:

"Peering into a hole I saw a fine large crab. I pulled him out, and carried him home. There came out with him the claw of a crab of similar size, but quite soft, which I supposed might have been carried in there by my gentleman to eat. After I had got him out—it was a male—I looked in, and saw another at the bottom of the hole. Arrived at home, I found that I had left my pocket-knife at the mouth of the crab-hole. I returned; the crab had not moved. I drew it out. But lo! it was a soft crab, the shell being of the consistence of wet parchment. It was a female, too, and had lost one claw. What, then, are we to infer from this association? Do the common crabs live in pairs? And does one keep guard at the mouth of the cavern, while its consort is undergoing its change of skin? I have no doubt that the claw of its mate was unintentionally torn off in its efforts to effect some hold, when resisting my tugs in dragging him out."

But it is in America, after all, that the habits of crabs at their

time of exuviation should be the best known. The soft-shell crab is condemned as food in Europe, it being considered as in a sickly state at that time, just as birds are when moulting. And may not this be so? However, in this country the procuring of the soft-shell crab is a great and profitable industry. Hence any intelligent "crabber" knows a good deal of their habits. For many years we knew an old fisherman. He was quite illiterate, but of more than the average intelligence of his class. He was an old "crabber" too. As he long supplied my family with fish, I often got him into conversation. But here I must be allowed to quote myself, as in the *American Naturalist*, vol. iii., giving the old man's own words: "I hev ketched soft crabs for market many a year. The crab sheds every year, chiefly in early summer. At that time the he one is mighty kind to his mate. When she shows signs of shedding, the he one comes along, and gets on the she one's back, quite tenderly-like, and entirely protects her from all enemies, whether of fishes, or of their own kind. She is now getting ready to shed, and is called a *shedder*. Soon the back begins to burst nigh to the tail. She is then called a *buster*. The he one is then very anxious to find a good place for her, either by digging a hole in the sand, or mud, or else looking up a good cover under some sea-weed. Here he brings her, all the time hovering nigh, and doing battle for her, if any thing comes along. She now—and it only takes a few minutes—withdraws from the old shell. And she comes out perfect, in every part, even to the inside of the hairs, the eyes, and long feelers, almost like the whiskers of a cat. At the first tide she is *fat*, and the shell is soft, just like a thin skin. She is then called a *soft-shell*, and it's the first-tiders that bring the high price. At the second tide she is perfectly watery, and transparent, and is then called a *buckler;* but she is not worth much then. At the third tide she is again a *hard-shell*, as she always was, only bigger."

"Have you seen all this with your own eyes?" we asked.

"Lor', sir, yes; hundreds and hundreds of times."

To the epicure, the soft-shell crab, when fried, is a great dainty. It is eaten entirely, like boned turkey; and, as a luxury, might be compared to a boneless fish. That it is an entirely unobjectionable food, is far from certain. It does not agree with every one, that is sure. It is a great business in New Jersey. Almost any morning, in summer, the sight may be seen at the Port Monmouth dock of unloading them from the cars on to the steamboat. They are shipped to market in boxes, each containing about six dozen of these soft-shell crabs, and covered on the top with wet sea-weed. Some idea of the importance of this business, while it lasts, may be formed from the fact that the neighborhood of Shark River will ship daily about five hundred dozen. These will bring, on an average, about $1.50 a dozen. When scarce, they bring almost fabulous prices. The business is, however, somewhat precarious. In some places, noted for being good,

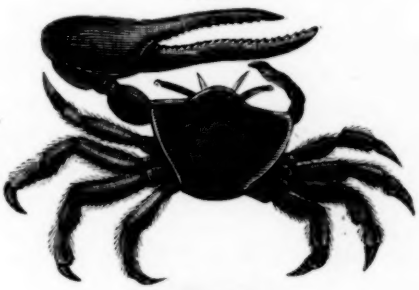
a seeming desertion sometimes occurs, which may continue for several seasons. Shark River is a good crabbing-ground, and yet it is subject to a closing up at the mouth by the washing up of the sea. When this occurs, the water is too fresh, and the crabs may perish.

The crabbers are now working more systematically. They build pens, or cars, out in the water, the top being opened to the light, and the sides being latticed, or made of laths, which admit the water freely. The bottom is covered with clean stones or coarse gravel. Into these the crabs are put as fast as caught, whether shedding or not; and, as fast as they shed, they are taken out.

As mentioned, our edible crab literally backs out of the shell; that is, it comes out at an opening behind. The *Limulus*, or horseshoe-crab, acts directly contrariwise. The shell cracks open at the front, and the animal emerges forward, instead of from behind, or backward. In fact, the structure of the shell makes this the only possible mode. A few years ago, the officers superintending the building of the fort at Sandy Hook became greatly interested at witnessing this exuviation of the shell of *Limulus Polyphemus*, and they declared that the fellow was spewing himself out of his mouth!

But we have two others to introduce—a brace of queer creatures they are, truly; and one of them is a positively "crusty customer." Some call him the soldier-crab; and certainly, if agility and seeming courage make up the martial element, then a valorous little fellow he is. The males have one hand enormously large. This, when closed upon the front of the body, is suggestive of the attitude of a violinist—hence we boys used to call it the fiddler-crab, Fig. 3. The natural-

FIG. 3.



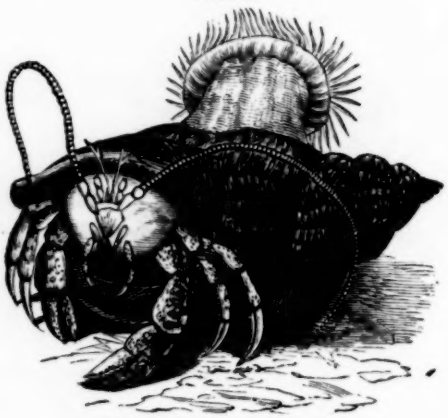
FIDDLER-CRAB.

ist names it *Gelasimus vocans*, a name highly expressive of its attributes. Some have rendered the words "calling crab." This is too far short of their significance. The words are intended to indicate both the action of the crab and its effect upon the beholder. When alarmed, they go scuttling over the mud to their burrows, the males each holding his great claw aloft, and waving it in a manner that looks ludicrously like beckoning, or challenging, and at the same time

threatening, and this, too, while in full and masterly retreat. Each seems, as it might be, a Liliputian Falstaff; and, if rendered in Homeric strain, *Gelasimus vocans* would signify the "laughter-provoking challenger." Indeed, Gelasimus never sees anybody, whether great or small, but forth he hurls his challenge in pantomime, for up goes that threatening huge member, so that its owner appears to be habitually bent on something high-handed. As this swaying of the great fiddle-like claw seems to start and direct or animate the retreat, it is ludicrously suggestive of a musical conductor beating time by swaying a bass-viol instead of his *bâton*, the effect of his eccentricity being to cause a stampede of all the fiddlers. This crab excavates holes in the earth, a male and a female occupying one hole. Into this retreat it retires with astonishing celerity when alarmed, and, having gained its hole, it literally barricades the entrance, by turning round and closing it up with its big hand, leaving just room enough for the little keen eyes to keep a sharp lookout at whatever may be passing. In these burrows they spend the winter, probably in hibernation. More than once, when pursuing the fiddler who, with fiddle aloft, ran swiftly, has the writer had the luxury of a slip and fall on the slimy clay of Fiddler Town, as we called a certain place in the salt-meadows, where these fiddlers lived. Those mishaps were really enjoyable—that is, to those who looked on.

There is a group of crabs which has a curious habit, made necessary on account of the unprotected condition of the hinder part of

FIG. 4.



HERMIT-CRAB AND ACTINEA.

their bodies. This is entirely naked; hence these crabs occupy the empty shells of sea-snails, winkles, and such univalves. It is called the hermit-crab, or *Pagurus*, by the systematists, Fig. 4. The most common species on the Atlantic coast is the little hermit—*Pagurus longicarpus*. A pair of nippers at the extremity of the tail, or naked abdomen, en-

ables it to grip the columella, or upper part of the inside of the shell that it occupies, thus keeping itself snugly in place. As the crab increases in size by growth, it has to change its home for one more roomy; and this leads to some remarkable exhibitions of its instincts. The sight, which we have often beheld, is one of exciting interest. Watch, now, if you please. Here is a fat little hermit-crab, whose domicile, like a strait-jacket, has become decidedly uncomfortable, and he is somewhat distracted about it. He is out a house-hunting—that is a literal fact. See, he has found an empty shell. It is not so handsome as the one he now occupies, but it is a little larger. Look, how he almost lifts it up among his ten feet, every one of which is an interested inspector, as each must bear its part in sustaining the establishment. Now he rolls it round and round, all over and over, delicately manipulating its sculpture occasionally; he is not only testing its specific gravity like a philosopher, but also seems to have an eye to appearances. Now comes the most essential, the inspection of the interior. Will it fit? That is the chief consideration. He inserts his longest finger, and thoroughly probes the whole matter. One more trial—and now it seems that the antennæ, or feelers, enter into the consultation. And what an amount of feeling deliberation does this step involve! Well, the thing appears to be satisfactory. It is evidently decided that the new house will answer. And now comes the most trying time of all—for "moving" is a trying time. But Pagurus is actuated by considerations that fall not to the lot of migratory mortals of the bipedal sort. His accountability is of the ten-talent order. With his eyes he surveys the entire situation. What! Yes, it is so! He has moved, and settled, and has got the house "all to-rights." The whole thing was done in the twinkling of an eye. It vacates the old house, whisks its tail round, and enters the new one backward, as if shot into it from a gun. In fact, unless watching intently, the whole movement will elude the eye, like a trick of legerdemain. And the cause is not far to seek. If that soft, nude, defenceless body were exposed but for an instant, it might become the prey of some darting fish.

These hermit-crabs are highly pugnacious. We once took a pair of them that we suspected of being anxious to change their houses. They were put in a vessel of sea-water, and, full in sight of them, was placed an empty winkle-shell, which we supposed was of the right size. How they did fight for it! It was a battle for life. One succumbed, at last, and died. The survivor coolly surveyed his victim, and then surveyed the new premises. After this, he promptly entered into possession; and then, pitiful to relate, he fell-to eating his defunct comrade. Oh, the cannibal!

The cut (Fig. 4) given of a hermit-crab shows actinea, or zoöphite, upon the shell. These are sometimes called sea-anemones, and animal flowers, on account of their being real animals, with a flower-like form.

The class Crustacea, which embraces the creatures of whom we

have given this brief sketch, is immense in the number of species which compose it; and these have a wide range of size, some being so small as to be only discernible by the microscope, while some are many feet in length. The hugest of them all is a spider-like creature, the *Macrocheira*, or long-armed crab of Japan. The cabinet of Rutgers College, New Jersey, contains one of them. It is the *Macrocheira Camperi*. We made an actual measure of it, and found that, with its long limbs extended, it had a length of eleven feet six inches. This specimen is probably the largest known.

After a while, a crab ceases to grow. Of course, then all enlargement stops, and it is no longer necessary for it to get new clothes, as the old ones are large enough. It is liable now to become the victim of the strangest sort of parasitism. In the British Museum is an old crab of the edible species, with some half-dozen oysters of large size growing on its back, which load, ever increasing, the old crab was doomed to carry to the end of its days. A singular piece of imposition—and enough to make crabbed the disposition of the most amiable. Another specimen preserved is that of a hairy crab, whose habit seems to have been to encourage the presence of sponges. And it got "sponged on" with a vengeance, seeing that it is not larger than a walnut, and yet is saddled with a sponge as big as a man's fist.

SEX IN MIND AND IN EDUCATION.

By HENRY MAUDSLEY, M. D.

THOSE who view without prejudice, or with some sympathy, the movements for improving the higher education of women, and for throwing open to them fields of activity from which they are now excluded, have a hard matter of it sometimes to prevent a feeling of reaction being aroused in their minds by the arguments of the most eager of those who advocate the reform. Carried away by their zeal into an enthusiasm which borders on or reaches fanaticism, they seem positively to ignore the fact that there are significant differences between the sexes, arguing in effect as if it were nothing more than an affair of clothes, and to be resolved, in their indignation at woman's wrongs, to refuse her the simple rights of her sex. They would do better in the end if they would begin by realizing the fact that the male organization is one, and the female organization another, and that, let come what may in the way of assimilation of female and male education and labor, it will not be possible to transform a woman into a man. To the end of the chapter she will retain her special functions, and must have a special sphere of development and activity determined by the performance of those functions.

It is quite evident that many of those who are foremost in their zeal for raising the education and social status of woman, have not given proper consideration to the nature of her organization, and to the demands which its special functions make upon its strength. These are matters which it is not easy to discuss out of a medical journal; but, in view of the importance of the subject at the present stage of the question of female education, it becomes a duty to use plainer language than would otherwise be fitting in a literary journal. The gravity of the subject can hardly be exaggerated. Before sanctioning the proposal to subject woman to a system of mental training which has been framed and adapted for men, and under which they have become what they are, it is needful to consider whether this can be done without serious injury to her health and strength. It is not enough to point to exceptional instances of women who have undergone such a training, and have proved their capacities when tried by the same standard as men; without doubt there are women who can, and will, so distinguish themselves, if stimulus be applied and opportunity given; the question is, whether they may not do it at a cost which is too large a demand upon the resources of their nature. Is it well for them to contend on equal terms with men for the goal of man's ambition?

Let it be considered that the period of the real educational strain will commence about the time when, by the development of the sexual system, a great revolution takes place in the body and mind, and an extraordinary expenditure of vital energy is made, and will continue through those years after puberty when, by the establishment of periodical functions, a regularly recurring demand is made upon the resources of a constitution that is going through the final stages of its growth and development. The energy of a human body being a definite and not inexhaustible quantity, can it bear, without injury, an excessive mental drain as well as the natural physical drain which is so great at that time? Or, will the profit of the one be to the detriment of the other? It is a familiar experience that a day of hard physical work renders a man incapable of hard mental work, his available energy having been exhausted. Nor does it matter greatly by what channel the energy be expended; if it be used in one way it is not available for use in another. When Nature spends in one direction, she must economize in another direction. That the development of puberty does draw heavily upon the vital resources of the female constitution, needs not to be pointed out to those who know the nature of the important physiological changes which then take place. In persons of delicate constitution who have inherited a tendency to disease, and who have little vitality to spare, the disease is apt to break out at that time; the new drain established having deprived the constitution of the vital energy necessary to withstand the enemy that was lurking in it. The time of puberty

and the years following it are therefore justly acknowledged to be a critical time for the female organization. The real meaning of the physiological changes which constitute puberty is, that the woman is thereby fitted to conceive and bear children, and undergoes the bodily and mental changes that are connected with the development of the reproductive system. At each recurring period there are all the preparations for conception, and nothing is more necessary to the preservation of female health than that these changes should take place regularly and completely. It is true that many of them are destined to be fruitless so far as their essential purpose is concerned, but it would be a great mistake to suppose that on that account they might be omitted or accomplished incompletely, without harm to the general health. They are the expressions of the full physiological activity of the organism. Hence it is that the outbreak of disease is so often heralded, or accompanied, or followed by suppression or irregularity of these functions. In all cases they make a great demand upon the physiological energy of the body: they are sensitive to its sufferings, however these be caused; and, when disordered, they aggravate the mischief that is going on.

When we thus look the matter honestly in the face, it would seem plain that women are marked out by Nature for very different offices in life from those of men, and that the healthy performance of her special functions renders it improbable she will succeed, and unwise for her to persevere, in running over the same course at the same pace with him. For such a race she is certainly weighted unfairly. Nor is it a sufficient reply to this argument to allege, as is sometimes done, that there are many women who have not the opportunity of getting married, or who do not aspire to bear children; for whether they care to be mothers or not, they cannot dispense with those physiological functions of their nature that have reference to that aim, however much they might wish it, and they cannot disregard them in the labor of life without injury to their health. They cannot choose but to be women: cannot rebel successfully against the tyranny of their organization, the complete development and function whereof must take place after its kind. This is not the expression of prejudice nor of false sentiment; it is the plain statement of a physiological fact. Surely, then, it is unwise to pass it by; first or last it must have its due weight in the determination of the problem of woman's education and mission; it is best to recognize it plainly, however we may conclude finally to deal with it.

It is sometimes said, however, that sexual difference ought not to have any place in the culture of the mind, and one hears it affirmed with an air of triumphant satisfaction that there is no sex in mental culture. This is a rash statement, which argues want of thought or insincerity of thought in those who make it. There is sex in mind as distinctly as there is sex in body; and, if the mind is to receive

the best culture of which its nature is capable, regard must be had to the mental qualities which correlate differences of sex. To aim, by means of education and pursuits in life, to assimilate the female to the male mind, might well be pronounced as unwise and fruitless a labor as it would be to strive to assimilate the female to the male body by means of the same kind of physical training and by the adoption of the same pursuits. Without doubt there have been some striking instances of extraordinary women who have shown great mental power, and these may fairly be quoted as evidence in support of the right of women to the best mental culture; but it is another matter when they are adduced in support of the assertion that there is no sex in mind, and that a system of female education should be laid down on the same lines, follow the same method, and have the same ends in view, as a system of education for men.

Let me pause here to reflect briefly upon the influence of sex upon mind. In its physiological sense, with which we are concerned here, mind is the sum of those functions of the brain which are commonly known as thought, feeling, and will. Now, the brain is one among a number of organs in the commonwealth of the body; with these organs it is in the closest physiological sympathy by definite paths of nervous communication, has special correspondence with them by internuncial nerve-fibres; so that its functions habitually feel and declare the influence of the different organs. There is an intimate consensus of functions. Though it is the highest organ of the body, the coördinating centre to which impressions go and from which responses are sent, the nature and functions of the inferior organs with which it lives in unity affect essentially its nature as the organ of mental functions. It is not merely that disorder of a particular organ hinders or oppresses these functions, but it affects them in a particular way; and we have good reason to believe that this special pathological effect is a consequence of the specific physiological effect which each organ exerts naturally upon the constitution and function of mind. A disordered liver gives rise to gloomy feelings; a diseased heart, to feelings of fear and apprehension; morbid irritation of the reproductive organs, to feelings of a still more special kind—these are familiar facts; but what we have to realize is, that each particular organ has, when not disordered, its specific and essential influence in the production of certain passions or feelings. From of old the influence has been recognized, as we see in the doctrine by which the different passions were located in particular organs of the body, the heart, for example, being made the seat of courage, the liver the seat of jealousy, the bowels the seat of compassion; and although we do not now hold that a passion is aroused anywhere else than in the brain, we believe nevertheless that the organs are represented in the primitive passions, and that, when the passion is aroused into violent action by some outward cause, it will discharge itself upon the organ and throw its functions into commotion. In fact,

as the uniformity of thought among men is due to the uniform operation of the external senses, as they think alike because they have the same number and kind of senses, so the uniformity of their fundamental passions is due probably to the uniform operation of the internal organs of the body upon the brain; they feel alike because they have the same number and kind of internal organs. If this be so, these organs come to be essential constituents of our mental life.

The most striking illustration of the kind of organic action which I am endeavoring to indicate, is yielded by the influence of the reproductive organs upon the mind; a complete mental revolution being made when they come into activity. As great a change takes place in the feelings and ideas, the desires and will, as it is possible to imagine, and takes place in virtue of the development of their functions. Let it be noted, then, that this great and important mental change is different in the two sexes, and reflects the difference of their respective organs and functions. Before experience has opened their eyes, the dreams of a young man and maiden differ. If we give attention to the physiology of the matter, we see that it cannot be otherwise, and if we look to the facts of pathology, which would not fitly be in place here, they are found to furnish the fullest confirmation of what might have been predicted. To attribute to the influence of education the mental differences of sex which declare themselves so distinctly at puberty, would be hardly less absurd than to attribute to education the bodily differences which then declare themselves. The comb of a cock, the antlers of a stag, the mane of a lion, the beard of a man, are growths in relation to the reproductive organs which correlate mental differences of sex as marked almost as these physical differences. In the first years of life, girls and boys are much alike in mental and bodily character, the differences which are developed afterward being hardly more than intimated, although some have thought the girl's passion for her doll evinces even at that time a forefeeling of her future functions; during the period of reproductive activity, the mental and bodily differences are declared most distinctly; and when that period is past, and man and woman decline into second childhood, they come to resemble one another more again. Furthermore, the bodily form, the voice, and the mental qualities of mutilated men approach those of women; while women whose reproductive organs remain from some cause in a state of arrested development, approach the mental and bodily habits of men.

No psychologist has yet devoted himself to make, or has succeeded in making, a complete analysis of the emotions, by resolving the complex feelings into their simple elements and tracing them back from their complex evolutions to the primitive passions in which they are rooted; this is a promising and much-needed work which remains to be done; but, when it is done, it will be shown probably that they have proceeded originally from two fundamental instincts, or—if we add con-

sciousness of nature and aim—passions, namely, that of self-preservation, with the ways and means of self-defense which it inspires and stimulates, and that of propagation, with the love of offspring and other primitive feelings that are connected with it. Could we in imagination trace mankind backward along the path stretching through the ages, on which it has gone forward to its present height and complexity of emotion, and suppose each new emotional element to be given off at the spot where it was acquired, we should view a road along which the fragments of our high, special, and complex feelings were scattered, and should reach a starting-point of the primitive instincts of self-preservation and propagation. Considering, then, the different functions of the sexes in the operation of the latter instinct, and how a different emotional nature has necessarily been grafted on the original differences in the course of ages,[1] does it not appear that in order to assimilate the female to the male mind it would be necessary to undo the life-history of mankind from its earliest commencement? Nay, would it not be necessary to go still farther back to that earliest period of animal life upon earth before there was any distinction of sex?

If the foregoing reflections be well grounded, it is plain we ought to recognize sex in education, and to provide that the method and aim of mental culture should have regard to the specialties of woman's physical and mental nature. Each sex must develop after its kind; and if education in its fundamental meaning be the external cause to which evolution is the internal answer, if it be the drawing out of the internal qualities of the individual into their highest perfection by the influence of the most fitting external conditions, there must be a difference in the method of education of the two sexes answering to differences in their physical and mental natures. Whether it be only the statement of a partial truth, that "for valor he" is formed, and "for beauty she and sweet attractive grace," or not, it cannot be denied that they are formed for different functions, and that the influence of these functions pervades and affects essentially their entire beings. There is sex in mind, and there should be sex in education.

Let us consider, then, what an adapted education must have regard to. In the first place, a proper regard to the physical nature of women means attention given, in their training, to their peculiar functions and to their foreordained work as mothers and nurses of children. Whatever aspirations of an intellectual kind they may have, they cannot be relieved from the performance of those offices so long as it is thought necessary that mankind should continue on earth. Even if these be looked upon as somewhat mean and unworthy offices in comparison with the nobler functions of giving birth to and developing ideas; if, agreeing with Goethe, we are disposed to hold—"Es wäre doch immer

[1] The instinct of propagation is what we are concerned with here, but it should not be overlooked that, in like manner, a difference of character would grow out of the instinct of self-preservation and the means of self-defense prompted by it.

hübscher wenn man die Kinder von den Baumen schüttelte;" it must still be confessed that for the great majority of women they must remain the most important offices of the best period of their lives. Moreover, they are work which, like all work, may be well or ill done, and which, in order to be done well, cannot be done in a perfunctory manner, as a thing by the way. It will have to be considered whether women can scorn delights, and live laborious days of intellectual exercise and production, without injury to their functions as the conceivers, mothers, and nurses of children. For, it would be an ill thing, if it should so happen that we got the advantages of a quantity of female intellectual work at the price of a puny, enfeebled, and sickly race. In this relation, it must be allowed that women do not and cannot stand on the same level as men.

In the second place, a proper regard to the mental nature of woman means attention given to those qualities of mind which correlate the physical differences of her sex. Men are manifestly not so fitted mentally as women to be the educators of children during the early years of their infancy and childhood; they would be almost as much out of place in going systematically to work to nurse babies as they would be in attempting to suckle them. On the other hand, women are manifestly endowed with qualities of mind which specially fit them to stimulate and foster the first growths of intelligence in chilren, while the intimate and special sympathies which a mother has with her child as a being which, though individually separate, is still almost a part of her nature, give her an influence and responsibilities which are specially her own. The earliest dawn of an infant's intelligence is its recognition of its mother as the supplier of its wants, as the person whose near presence is associated with the relief of sensations of discomfort, and with the production of feelings of comfort; while the relief and pleasure which she herself feels in yielding it warmth and nourishment strengthen, if they were not originally the foundation of, that strong love of offspring which with unwearied patience surrounds its wayward youth with a thousand ministering attentions. It can hardly be doubted that, if the nursing of babies were given over to men for a generation or two, they would abandon the task in despair or in disgust, and conclude it to be not worth while that mankind should continue on earth. But "can a woman forget her sucking child, that she should not have compassion on the son of her womb?" Those can hardly be in earnest who question that woman's sex is represented in mind, and that the mental qualities which spring from it qualify her especially to be the successful nurse and educator of infants and young children.

Furthermore, the female qualities of mind which correlate her sexual character adapt her, as her sex does, to be the helpmate and companion of man. It was an Eastern idea, which Plato has expressed allegorically, that a complete being had in primeval times

been divided into two halves, which have ever since been seeking to unite together and to reconstitute the divided unity. It will hardly be denied that there is a great measure of truth in the fable. Man and woman do complement one another's being. This is no less true of mind than it is of body; is true of mind indeed as a consequence of its being true of body. Some may be disposed to argue that the qualities of mind which characterize women now, and have characterized them hitherto, in their relations with men, are in great measure, mainly if not entirely, the artificial results of the position of subjection and dependence which she has always occupied; but those who take this view do not appear to have considered the matter as deeply as they should; they have attributed to circumstances much of what unquestionably lies deeper than circumstances, being inherent in the fundamental character of sex. It would be a delusive hope to expect, and a mistaken labor to attempt, to eradicate by change of circumstances the qualities which distinguish the female character, and fit woman to be the helpmate and companion of man in mental and bodily union.

So much may be fairly said on general physiological grounds. We may now go on to inquire whether any ill effects have been observed from subjecting women to the same kind of training as men. The facts of experience in this country are not such as warrant a full and definite answer to the inquiry, the movement for revolutionizing the education of women being of a recent date. But in America the same method of training for the sexes in mixed classes has been largely applied; girls have gone with boys through the same curriculum of study, from primary to grammar schools, from schools to graduation in colleges, working early under the stimulus of competition, and disdaining any privilege of sex. With what results? With one result certainly—that, while those who are advocates of the mixed system bear favorable witness to the results upon both sexes, American physicians are beginning to raise their voices in earnest warnings and protests. It is not that girls have not ambition, nor that they fail generally to run the intellectual race which is set before them, but it is asserted that they do it at a cost to their strength and health which entails life-long suffering, and even incapacitates them for the adequate performance of the natural functions of their sex. Without pretending to indorse these assertions, which it would be wrong to do in the absence of sufficient experience, it is right to call attention to them, and to claim serious consideration for them; they proceed from physicians of high professional standing, who speak from their own experience, and they agree, moreover, with what perhaps might have been feared or predicted on physiological grounds. It may fairly be presumed that the stimulus of competition will act more powerfully on girls than on boys; not only because they are more susceptible by nature, but because it will produce more effect upon their constitu-

tions when it is at all in excess. Their nerve-centres being in a state of greater instability, by reason of the development of their reproductive functions, they will be the more easily and the more seriously deranged. A great argument used in favor of a mixed education is that it affords adequate stimulants to girls for thorough and sustained work, which have hitherto been a want in girls' schools; that it makes them less desirous to fit themselves only for society, and content to remain longer and work harder at school. Thus it is desired that emulation should be used in order to stimulate them to compete with boys in mental exercises and aims, while it is not pretended they can or should compete with them in those out-door exercises and pursuits which are of such great benefit in ministering to bodily health, and to success in which boys, not unwisely perhaps, attach scarcely less honor than to intellectual success. It is plain, then, that the stimulus of competition in studies will act more powerfully upon them, not only because of their greater constitutional susceptibility, but because it is left free to act without the compensating balance of emulation in other fields of activity. Is it right, may well be asked, that it should be so applied? Can woman rise high in spiritual development of any kind unless she take a holy care of the temple of her body?[1]

A small volume, entitled "Sex in Education," which has been published recently by Dr. Edward Clarke, of Boston, formerly a professor in Harvard College, contains a somewhat startling description of the baneful effects upon female health which have been produced by an excessive educational strain. It is asserted that the number of female graduates of schools and colleges who have been permanently disabled to a greater or less degree by improper methods of study, and by a disregard of the reproductive apparatus and its functions, is so great as to excite the gravest alarm, and to demand the serious attention of the community. "If these causes should continue for the next half-century, and increase in the same ratio as they have for the last fifty years, it requires no prophet to foretell that the wives who are to be the mothers in our republic must be drawn from transatlantic homes. The sons of the New World will have to react, on a magnificent scale, the old story of unwived Rome and the Sabines." Dr. Clarke relates the clinical histories of several cases of tedious illness, in which he traced the cause unhesitatingly to a disregard of the function of the female organization. Irregularity, imperfection, arrest, or excess, occurs in consequence of the demand made upon the vital powers at times when there should rightly be an intermission or remission of labor, and is

[1] Of all the intellectual errors of which men have been guilty, perhaps none is more false and has been more mischievous in its consequences than the theologico-metaphysical doctrine which inculcated contempt of the body as the temple of Satan, the prison-house of the spirit, from which the highest aspiration of mind was to get free. It is a foolish and fruitless labor to attempt to divorce or put asunder mind and body, which Nature has joined together in essential unity; and the right culture of the body is not less a duty than, is indeed essential to, the right culture of the mind.

followed first by pallor, lassitude, debility, sleeplessness, headache, neuralgia, and then by worse ills. The course of events is something in this wise: The girl enters upon the hard work of school or college at the age of fifteen years or thereabouts, when the function of her sex has perhaps been fairly established; ambitious to stand high in class, she pursues her studies with diligence, perseverance, constancy, allowing herself no days of relaxation or rest out of the school-days, paying no attention to the periodical tides of her organization, unheeding a drain "that would make the stroke oar of the university crew falter." For a time all seems to go well with her studies; she triumphs over male and female competitors, gains the front rank, and is stimulated to continued exertions in order to hold it. But in the long-run Nature, which cannot be ignored or defied with impunity, asserts its power; excessive losses occur; health fails, she becomes the victim of aches and pains, is unable to go on with her work, and compelled to seek medical advice. Restored to health by rest from work, a holiday at the sea-side, and suitable treatment, she goes back to her studies, to begin again the same course of unheeding work, until she has completed the curriculum, and leaves college a good scholar but a delicate and ailing woman, whose future life is one of more or less suffering. For she does not easily regain the vital energy which was recklessly sacrificed in the acquirement of learning; the special functions which have relation to her future offices as woman, and the full and perfect accomplishment of which is essential to sexual completeness, have been deranged at a critical time; if she is subsequently married, she is unfit for the best discharge of maternal functions, and is apt to suffer from a variety of troublesome and serious disorders in connection with them. In some cases the brain and the nervous system testify to the exhaustive efforts of undue labor, nervous and even mental disorders declaring themselves.

Such is a picture, painted by an experienced physician, of the effects of subjecting young women to the method of education which has been framed for young men. Startling as it is, there is nothing in it which may not well be true to Nature. If it be an effect of excessive and ill-regulated study to produce derangement of the functions of the female organization, of which so far from there being an antecedent improbability there is a great probability, then there can be no question that all the subsequent ills mentioned are likely to follow. The important physiological change which takes place at puberty, accompanied, as it is, by so great a revolution in mind and body, and by so large an expenditure of vital energy, may easily and quickly overstep its healthy limits and pass into a pathological change, under conditions of excessive stimulation, or in persons who are constitutionally feeble and whose nerve-centres are more unstable than natural; and it is a familiar medical observation that many nervous disorders of a minor kind, and even such serious disorders as chorea,

epilepsy, insanity, are often connected with irregularities or suppresion of these important functions.

In addition to the ill effects upon the bodily health which are produced directly by an excessive mental application, and a consequent development of the nervous system at the expense of the nutritive functions, it is alleged that remoter effects of an injurious character are produced upon the entire nature, mental and bodily. The arrest of development of the reproductive system discovers itself in the physical form and in the mental character. There is an imperfect development of the structure which Nature has provided in the female for nursing her offspring.

"Formerly," writes another American physician, Dr. N. Allen, "such an organization was generally possessed by American women, and they found but little difficulty in nursing their infants. It was only occasionally in case of some defect in the organization, or where sickness of some kind had overtaken the mother, that it became necessary to resort to the wet-nurse, or to feeding by hand. And the English, the Scotch, the German, the Canadian, the French, and the Irish women who are living in this country, generally nurse their children; the exceptions are rare. But how is it with our American women who become mothers? It has been supposed by some that all, or nearly all of them, could nurse their offspring just as well as not; that the disposition only was wanting, and that they did not care about having the trouble or confinement necessarily attending it. But this is a great mistake. This very indifference or aversion shows something wrong in the organization, as well as in the disposition; if the physical system were all right, the mind and natural instincts would generally be right also. While there may be here and there cases of this kind, such an indisposition is not always found. It is a fact that large numbers of our women are anxious to nurse their offspring, and make the attempt; they persevere for a while—perhaps for weeks or months—and then fail. . . . There is still another class that cannot nurse at all, having neither the organs nor nourishment necessary to make a beginning."

Why should there be such a difference between American women and those of foreign origin residing in the same locality, or between them and their grandmothers? Dr. Allen goes on to ask. The answer he finds in the undue demands made upon the brain and nervous system, to the detriment of the organs of nutrition and secretion:

"In consequence of the great neglect of physical exercise, and the continuous application to study, together with various other influences, large numbers of our American women have altogether an undue predominance of the nervous temperament. If only here and there an individual were found with such an organization, not much harm comparatively would result; but when a majority, or nearly a majority have it, the evil becomes one of no small magnitude."

To the same effect writes Dr. Weir Mitchell, an eminent American physiologist:

"Worst of all, to my mind, most destructive in every way, is the American view of female education. The time taken for the more serious instruction of girls extends to the age of eighteen, and rarely over this. During these years

they are undergoing such organic development as renders them remarkably sensitive. . . . To-day the American woman is, to speak plainly, physically unfit for her duties as woman, and is, perhaps, of all civilized females, the least qualified to undertake those weightier tasks which tax so heavily the nervous system of man. She is not fairly up to what Nature asks from her as wife and mother. How will she sustain herself under the pressure of those yet more exacting duties which nowadays she is eager to share with man?"

Here, then, is no uncertain testimony as to the effects of the American system of female education: some women who are without the instinct or desire to nurse their offspring, some who have the desire but not the capacity, and others who have neither the instinct nor the capacity. The facts will hardly be disputed, whatever may finally be the accepted interpretation of them. It will not probably be argued that an absence of the capacity and the instinct to nurse is a result of higher development, and that it should be the aim of woman, as she advances to a higher level, to allow the organs which minister to this function to waste and finally to become by disuse as rudimentary in her sex as they are in the male sex. Their development is notably in close sympathy with that of the organs of reproduction, an arrest thereof being often associated with some defect of the latter; so that it might perhaps fairly be questioned whether it was right and proper, for the race's sake, that a woman who has not the wish or power to nurse should indulge in the functions of maternity. We may take note, by-the-way, that those in whom the organs are wasted invoke the dress-maker's aid in order to gain the appearance of them; they are not satisfied unless they wear the show of perfect womanhood. However, it may be in the plan of evolution to produce at some future period a race of sexless beings who, undistracted and unharassed by the ignoble troubles of reproduction, shall carry on the intellectual work of the world, not otherwise than as the sexless ants do the work and the fighting of the community.

Meanwhile, the consequences of an imperfectly developed reproductive system are not sexual only; they are also mental. Intellectually and morally there is a deficiency, or at any rate a modification answering to the physical deficiency; in mind, as in body, the individual fails to reach the ideal of a complete and perfect womanhood. If the aim of a true education be to make her reach *that*, it cannot certainly be a true education which operates in any degree to unsex her; for sex is fundamental, lies deeper than culture, cannot be ignored or defied with impunity. You may hide Nature, but you cannot extinguish it. Consequently, it does not seem impossible that, if the attempt to do so be seriously and persistently made, the result may be a monstrosity—something which having ceased to be woman is yet not man—"ce quelque chose de monstrueux," which the Comte A. de Gasparin forebodes, "cet être répugnant, qui déjà paraît à notre horizon."

The foregoing considerations go to show that the main reason of woman's position lies in her nature. That she has not competed with men in the active work of life was probably because, not having had the power, she had not the desire to do so, and because, having the capacity of functions which man has not, she has found her pleasure in performing them. It is not simply that man, being stronger in body than she is, has held her in subjection, and debarred her from careers of action which he was resolved to keep for himself; her maternal functions must always have rendered, and must continue to render, most of her activity domestic. There have been times enough in the history of the world when the freedom which she has had, and the position which she has held in the estimation of men, would have enabled her to assert her claims to other functions, had she so willed it. The most earnest advocate of her rights to be something else than what she has hitherto been would hardly argue that she has always been in the position of a slave kept in forcible subjection by the superior physical force of men. Assuredly, if she has been a slave she has been a slave content with her bondage. But it may perhaps be said that in that lies the very pith of the matter—that she is not free, and does not care to be free; that she is a slave, and does not know or feel it. It may be alleged that she has lived for so many ages in the position of dependence to which she was originally reduced by the superior muscular strength of man, has been so thoroughly imbued with inherited habits of submission, and overawed by the influence of customs never questioned, that she has not the desire for emancipation; that thus a moral bondage has been established more effectual than an actual physical bondage. That she has now exhibited a disposition to emancipate herself, and has initiated a movement to that end, may be owing partly to the easy means of intellectual intercommunication in this age, whereby a few women scattered through the world, who felt the impulses of a higher inspiration, have been enabled to coöperate in a way that would have been impossible in former times, and partly to the awakened moral sense, and to the more enlightened views of men, which have led to the encouragement and assistance, instead of the suppression, of their efforts.

It would be rash to assert that there is not some measure of truth in these arguments. Let any one who thinks otherwise reflect upon the degraded condition of women in Turkey, where habit is so ingrained in their nature, and custom so powerful over the mind, that they have neither thought nor desire to attain to a higher state, and "naught feel their foul disgrace:" a striking illustration how women may be demoralized and yet not know or feel it, and an instructive lesson for those who are anxious to form a sound judgment upon the merits of the movement for promoting their higher education and the removal of the legal disabilities under which they labor. It is hardly

possible to exaggerate the effects of the laws and usages of a country upon the habits of thought of those who, generation after generation, have been born, and bred, and have lived under them. Were the law, which ordains that, when a father dies intestate, all the real property of which he is possessed shall be inherited by his eldest son, his other children being sent empty away, enacted for the first time, there is no one, probably, who would not be shocked by its singular injustice; yet the majority of persons in this country are far from thinking it extraordinary or unjust, and a great many of them would deem it a dangerous and wicked doctrine to question its justice. Only a few weeks ago, a statesman who has held high offices in a Conservative ministry, in an address to electors, conjured them not to part with the principle of primogeniture, and declared that there was no change in the law which he would so vehemently oppose as this: "Let them but follow the example of a neighboring nation in this respect, and there was an end of their personal freedom and liberty!" So much do the laws and usages of a country affect the feelings and judgments of those who dwell therein. If we clearly apprehend the fact, and allow it the weight which it deserves, it will be apparent that we must hesitate to accept the subordinate position which women have always had as a valid argument for the justice of it, and a sufficient reason why they should continue forever in it.

But may we not fairly assert that it would be no less a mistake in an opposite direction to allow no weight to such an argument? Setting physiological considerations aside, it is not possible to suppose that the whole explanation of woman's position and character is that man, having in the beginning found her pleasing in his eyes and necessary to his enjoyment, took forcible possession of her, and has ever since kept her in bondage, without any other justification than the right of the strongest. Superiority of muscular strength, without superiority of any other kind, would not have done that, any more than superiority of muscular strength has availed to give the lion or the elephant possession of the earth. If it were not that woman's organization and functions found their fitting home in a position different from, if not subordinate to, that of men, she would not so long have kept that position. If she is to be judged by the same standard as men, and to make their aims her aims, we are certainly bound to say that she labors under an inferiority of constitution by a dispensation which there is no gainsaying. This is a matter of physiology, not a matter of sentiment; it is not a mere question of larger or smaller muscles, but of the energy and power of endurance of the nerve-force which drives the intellectual and muscular machinery; not a question of two bodies and minds that are in equal physical conditions, but of one body and mind capable of sustained and regular hard labor, and of another body and mind which for one quarter of each month during the best years of life is more or less sick and unfit for hard work. It

is in these considerations that we find the true explanation of what has been from the beginning until now, and what must doubtless continue to be, though it be in a modified form. It may be a pity for woman that she has been created woman, but, being such, it is as ridiculous to consider herself inferior to man because she is not man, as it would be for man to consider himself inferior to her because he cannot perform her functions. There is one glory of the man, another glory of the woman, and the glory of the one differeth from that of the other.

Taking into adequate account the physiology of the female organization, some of the statements made by the late Mr. Mill in his book on the subjection of women strike one with positive amazement. He calls upon us to own that what is now called the nature of women is an eminently artificial thing, the result of forced repression in some directions, of unnatural stimulation in others; that their character has been entirely distorted and disguised by their relations with their masters, who have kept them in so unnatural a state; that if it were not for this there would not be any material difference, nor perhaps any difference at all, in the character and capacities which would unfold themselves; that they would do the same things as men fully as well on the whole, if education and cultivation were adapted to correcting, instead of aggravating, the infirmities incident to their temperament; and that they have been robbed of their natural development, and brought into their present unnatural state, by the brutal right of the strongest which man has used. If these allegations contain no exaggeration, if they be strictly true, then is this article an entire mistake.

Mr. Mill argues as if, when he has shown it to be probable that the inequality of rights between the sexes has no other source than the law of the strongest, he had demonstrated its monstrous injustice. But is that entirely so? After all, there is a right in might—the right of the strong to be strong. Men have the right to make the most of their powers, to develop them to the utmost, and to strive for, and if possible gain and hold, the position in which they shall have the freest play. It would be a wrong to the stronger if it were required to limit its exertions to the capacities of the weaker. And if it be not so limited, the result will be that the weaker must take a different position. Men will not fail to take the advantage of their strength over women: are no laws, then, to be made which, owning the inferiority of women's strength, shall ordain accordingly, and so protect them really from the mere brutal tyranny of might? Seeing that the greater power cannot be ignored, but in the long-run must tell in individual competition, it is a fair question whether it ought not to be recognized in social adjustments and enactments, even for the necessary protection of women. Suppose that all legal distinctions were abolished, and that women were allowed free play to do what they could, as it may

be right they should—to fail or succeed in every career upon which men enter; that all were conceded to them which their extremest advocates might claim for them; do they imagine that, if they, being in a majority, combined to pass laws which were unwelcome to men, the latter would quietly submit? Is it proposed that men should fight for them in war, and that they, counting a majority of votes, should determine upon war? Or would they no longer claim a privilege of sex in regard to the defense of the country by arms? If all barriers of distinction of sex raised by human agency were thrown down, as not being warranted by the distinctions of sex which Nature has so plainly marked, it may be presumed that the great majority of women would continue to discharge the functions of maternity, and to have the mental qualities which correlate these functions; and if laws were made by them, and their male supporters of a feminine habit of mind, in the interest of babies, as might happen, can it be supposed that, as the world goes, there would not soon be a revolution in the state by men, which would end in taking all power from women and reducing them to a stern subjection? Legislation would not be of much value unless there were power behind to make it respected, and in such case laws might be made without the power to enforce them, or for the very purpose of coercing the power which could alone enforce them.

So long as the differences of physical power and organization between men and women are what they are, it does not seem possible that they should have the same type of mental development. But while we see great reason to dissent from the opinions, and to distrust the enthusiasm, of those who would set before women the same aims as men, to be pursued by the same methods, it must be admitted that they are entitled to have all the mental culture and all the freedom necessary to the fullest development of their natures. The aim of female education should manifestly be the perfect development, not of manhood but of womanhood, by the methods most conducive thereto: so may women reach as high a grade of development as men, though it be of a different type. A system of education which is framed to fit them to be nothing more than the superintendents of a household and the ornaments of a drawing-room, is one which does not do justice to their nature, and cannot be seriously defended. Assuredly those of them who have not the opportunity of getting married suffer not a little, in mind and body, from a method of education which tends to develop the emotional at the expense of the intellectual nature, and by their exclusion from appropriate fields of practical activity. It by no means follows, however, that it would be right to model an improved system exactly upon that which has commended itself as the best for men. Inasmuch as the majority of women will continue to get married and to discharge the functions of mothers, the education of girls certainly ought not to be such as would in any way clash with their organization, injure their health, and unfit them for

these functions. In this matter the small minority of women who have other aims and pant for other careers, cannot be accepted as the spokeswomen of their sex. Experience may be left to teach them, as it will not fail to do, whether they are right or wrong in the ends which they pursue and in the means by which they pursue them: if they are right, they will have deserved well the success which will reward their faith and works; if they are wrong, the error will avenge itself upon them and upon their children, if they should ever have any. In the worst event they will not have been without their use as failures; for they will have furnished experiments to aid us in arriving at correct judgments concerning the capacities of women and their right functions in the universe. Meanwhile, so far as our present lights reach, it would seem that a system of education adapted to women should have regard to the peculiarities of their constitution, to the special functions in life for which they are destined, and to the range and kind of practical activity, mental and bodily, to which they would seem to be foreordained by their sexual organization of body and mind.

NOTE.—It is fair to say that other reasons for the alleged degeneracy of American women are given. For example, a correspondent writes from America: "The medical mind of the United States is arrayed in a very ill-tempered opposition, on assumed physiological grounds, to the higher education of women in a continuous curriculum, and especially to that coeducation which some colleges in the Western States, Oberlin, Antioch, inaugurated twenty years ago, and which latterly Cornell University has adopted. The experience of Cornell is too recent to prove any thing; but the Quaker college of Swarthmore claims a steady improvement on the health of its girl-graduates, dating from the commencement of their college course; and the Western colleges report successful results, mentally, morally, and physically, from their coeducation experiment. Ignoring these facts, the doctors base their war-cry on the not-to-be-disputed fact that American women are growing into more and more of invalidism with every year. Something of this is perhaps due to climate. I will not say to food; for the American *menu*, in the cities at least, has improved since Mr. Dickens's early days, and has learned to combine French daintiness, very happily, with the substantial requirements of an English table.

"American men, as a rule, 'break down' between forty and fifty, when an Englishman is but beginning to live his public and useful life. The mad excitement of business you have, as well as we; so it must be the unrest of the climate, and their unphilosophical refusal of open-air pleasures and exercise, which are to blame in the case of the men.

"There are other reasons which go to make up the languid young-ladyhood of the American girl. Her childhood is denied the happy

out-door sports of her brothers. There is a resolute shutting out of every thing like a noisy romp; the active games and all happy, boisterous plays, by field or roadside, are not *proper* to her! She is cased in a cramping dress, so heavy and inconvenient that no boy could wear it for a day without falling into gloomy views of life. All this martyrdom to propriety and fashion tells upon strength and symmetry, and the girl reaches womanhood a wreck. That she reaches it at all, under these suffering and bleached-out conditions, is due to her superior elasticity to resist a method of education which would have killed off all the boys years before. . . . There are abundant statistics to prove that hard study is the discipline and tonic most girls need to supplant the too great sentimentality and useless day-dreams fostered by fashionable idleness, and provocative of 'nerves,' melancholy, and inanition generally, and, so far as statistics can, that the women-graduates of these colleges make as healthy and happy wives and mothers as though they had never solved a mathematical problem, nor translated Aristotle."—*Fortnightly Review.*

NOSTALGIA.

By FERNAND PAPILLON.

TRANSLATED BY A. R. MACDONOUGH.

THOSE great changes of place, temporarily, by masses of people, which were brought about by the late war, have drawn the attention of physicians again to a very singular malady, nostalgia, or homesickness, some extremely noteworthy cases of which appeared, particularly among the *mobiles* collected at Paris during the siege. Indeed, homesickness is a real disease, occasioning a group of symptoms and disturbances of very definite character—a disease the more real, inasmuch as it often ends in death. An eminent physician, who had earlier opportunities as a health-officer in the navy, and lately again as chief of one of the great Paris ambulances, to study nostalgia very closely, Dr. Benoist de la Grandière, has published an essay on the subject which will give us some interesting facts.

Sauvage describes nostalgia by four words—*morositas*, *pervigilio*, *anorexia*, *asthenia*—which signify sadness, sleeplessness, want of appetite, and exhaustion. The patient very early loses his cheerfulness and vigor, and courts in solitude a surrender to the fixed idea that haunts him, the thought of his country. He dwells in charmed repetition upon the memories connected with the places where his early life was spent, and paints them with a world of dreams in which his imagination shuts itself so obstinately that nothing can call him away

from it. He shuns the persons once loved best, rejects all diversions, and is angered by any attempt to console him. The conviction cherished by fancy that he shall never see his country again, and the grief it inspires, bring on disturbances of function which at last affect the whole natural system. His features change, his eyes grow set and dull, his countenance wears a look of stupor, his motions then grow languid, and betray painful indecision of will. Anæmia follows, the skin becomes dry and clammy, the mucous tissues lose color, the secretions decrease, the pulse sinks, and disturbance of the circulation appears. With regard to the digestive functions, the disorder is not less serious; as the patient eats little or nothing, gastric difficulties ensue. In women, chlorosis occurs, with its usual train of varied nervous affections; they neglect their dress and all their interests of emotion, including coquetry; then follow intermitting chills and night-sweats, making what Broussais called the hectic fever, and Larry the dry consumption of the melancholy-mad. At length the intellect and the patient perish together, with a last sigh for the country never again to be seen. The chief and peculiar mark of this neurosis is that the sufferer knows he must die. It often happens that nostalgic patients voluntarily starve to death or commit suicide.

Nostalgia attacks by preference young people and those just entering youth, affecting all temperaments without distinction. It is oftenest remarked among soldiers. During the great wars of the Revolution and the Empire it often prevailed as an epidemic, and scourged our armies with severity. Desgenettes relates that at St.-Jean-d'Acre it added a new complication and a more fatal horror to the plague. On the pontoons at Cadiz and Plymouth, that served as prisons for the soldiers of General Dupont, after the capitulation of Baylen, it killed as many French as died from yellow fever. In Poland and in Russia it intensified all other epidemic disorders. Michel Lévy says that in 1831 the Twenty-first regiment of light infantry, then in the Morea, received a large number of young Corsican recruits, many of whom fell victims to nostalgia, in the hospital at Navarino.

During the last war nostalgia carried off many sufferers among our unhappy prisoners dispersed throughout Germany. It attacked the soldiers and *mobiles* during the siege of Paris, especially toward the close of it, when privations and successive defeats began to reduce the most robust organizations. Many of the cases of nostalgia then observed in the hospitals and ambulances presented a really piteous sight. One instance we personally saw. The 4th of January, 1871, the young Marquis R——, aged twenty-four, a *mobile* from Finisterre, entered the Bicêtre military hospital. He had a slight varioloid and a bronchial complaint, which were certain to be cured, and actually were so. Yet this illness gave him slight concern; he was the victim of other anxieties. He ate hardly any thing, and spent his time in tears and prayers, refusing all efforts to distract or console him. On the 10th of

January all symptoms of disease had disappeared, but his emaciation had so increased, and the sinking of his moral force was so alarming, that the house-physician thought it his duty to remonstrate kindly with him. Two soldiers and a nurse were placed in attendance on him, who talked with him constantly in the Breton dialect, about his country and his family. All these methods failed. On the 16th, when examined again by the physician, the young patient sighed sadly, and, with tears in his eyes, expressed himself nearly in these words: "It is all over; I am very sure of it; I am going to die, and you will not succeed in preventing it. I had never left Brittany; I was satisfied, rich, and happy; my father died without ever having been severe with me, leaving me always to do as I chose. I refused to go to college, and was educated at home; I grew up under the curé's training and instruction, and led the careless, pure, and honorable life of a Breton gentleman. Who would have told me that I should ever leave Finisterre, and come to die in a hospital-bed at the gates of Paris! I was sure of it, the day I left Brittany, that it was all over with me. I was at Villiers, at Champigny—I fought there, doing as the rest did, but God refused to take me. He chose to try me yet more, and I bow to his holy will. If you knew how I suffer! Never to see my mansion again, nor the forests, nor my flocks, my horse, and my dogs! May God shorten my misery, and pardon my weakness! How loud the guns sound this morning!—the building will be battered down—do not stay here—my last hour is near, and I wish to make ready for death as a good Christian." The 23d of January the patient's pulse was at 110, his skin dry, his eye brilliant, his mind wandering, and on the 28th, at ten in the morning, he died.

Benoist de la Grandière gives some curious details about nostalgia in different nations. The French, precisely because they are more attached to their country than any others, and feel a passionate aversion to expatriation, are the very ones whom nostalgia most readily attacks. The inhabitants of the western departments, particularly the Bretons, and next to them those of the southern provinces and of Corsica, are remarkably predisposed to it. The very religious life, the manners so unchanging and the customs so characteristic which have continued so long in Brittany, create bonds not to be severed without danger between the soil of ancient Armorica and its inhabitants. The Swiss, too, love their country warmly, and never quit it but with regret. Nostalgia is not uncommon in Italy, particularly since the transfer of conscripts from one end of the kingdom to the other has become the practice. Between 1867 and 1870, the Italian Army showed a total of 203 cases of positive nostalgia, eight of which were fatal. The English and the Germans leave their country with less reluctance. The English, above all, are spared nostalgia through their adventurous spirit, and it may be said that their country is wherever the British flag floats. The cosmopolitan character of the Germans is less posi-

tive. During the late war, nostalgia found quite a number of victims among the soldiers of the Landwehr; and, on a late journey to Alsatia, I satisfied myself that it affected the soldiers from Silesia and Pomerania.

Sagar says that love of country is strongest with those who are nearest to a state of nature. This is quite correct. Savages, men living under the rudest forms of civilization, in the most uninviting climates, grieve when they quit them. Foissar relates that a Lapp, brought to Poland, where every kindness was shown him, was seized with incurable sadness, and at last escaped and returned to his inhospitable country. Greenlanders who had been taken across to Denmark, risked certain death by trusting themselves to slight canoes to cross the ocean separating them from their own land. Similar facts have been observed among the North American Indians. Albert mentions the story of a young squaw, Couramé, a foundling in the forest, adopted by a rich family. "Take me back," she exclaimed, "take me back to the land where I was born. O mother! have you quite forgotten me?" Couramé fell ill, and wasted away. One day, falling in with some Indians of her tribe, she made her escape with them. Strange affinity! that unconquerable attachment of man to the soil, the climate, the aspect of the narrow-bounded region in which his childhood had been spent! What an argument to oppose to our international and humanitarian philosophers!

What, then, is this strange disease? Most physicians class it as a variety, one form, of insanity, a sort of mania or melancholy. Benoist de la Grandière does not so regard it; he discovers in it a nervous affection of the organs through which imagination and memory act. The very clear distinctions which he points out between nostalgia and other kinds of mental derangement justify his way of viewing it. Indeed, the nostalgic patient has no such senseless or extravagant notions as madmen have. He never fancies himself possessed of a devil, or changed to a wolf or a dog. He is not swayed, as are the melancholy-mad, by the dread or terror of some imagined ill. On the other hand, the subjects of mania, or hypochondria, are usually in good health; in spite of their deranged intellects, they retain their strength and good condition. The deep sadness of the nostalgic patient, on the contrary, produces its first effect by changing the functions of nutrition in him, and causing disturbances that are often fatal to life. The various conditions of insanity are hereditary, while nostalgia never is so. Besides, the especial characteristic of this disorder is that it may be cured with absolute certainty, when the troubles it has brought about have not yet endangered the health; restoring the patient to his family effects a complete cure. On the contrary, the attempt to satisfy an ambitious madman's dreams of greatness or of wealth, far from lessening his mental derangement, will only give it new violence.

Whatever the nature of it, there is but one way to cure the unhappy creature whom love of his country consumes and destroys, and that is to send him back to his own land. Where that remedy is not possible, and fortunately that is not often the case, the medical treatment of nostalgia is limited merely to moral and hygienic palliatives. The very first duty of physicians, whenever the causes of nostalgia seem threatening, is to adopt preventives of its fatal influence. With this object, it is essential to employ actively and to divert in all possible ways soldiers and sailors who are taken to a distance from their country. It seems to be settled, moreover, that nostalgia is far less common in the navy than among the land-forces, and the fact probably depends upon the careful attention with which officers of the navy exert themselves to provide for the amusement of sailors, and to guard them against *ennui*. Nothing is so gay as a vessel's crew. Discipline does not suffer by it, and obedience is only the more prompt. "A ship without singing aboard," says Foussagrives, "always leads us to suspect the moral government it is kept under." During the Chinese campaign, on board the Forbin, whose crew was entirely made up of Bretons, all important manœuvres were gone through with to the accompaniment of the national *biniou*.

In the case of nostalgic patients whose illness results from the isolation they are reduced to by the language they speak, association with people who speak the same tongue is often one of the most effectual remedies. Esquirol, remarking that all the Bretons placed in one of the halls of the Salpêtrière showed more serious symptoms than patients occupying beds in the other wards of the hospital, directed students from Brittany to be stationed in that hall, requesting them to talk in a friendly way in their native dialect with their compatriots. No other treatment was needed for the cure of nostalgic cases. During the siege of Paris similar facts often occurred. In the ambulances, countrymen, particularly Bretons, were remarked growing perceptibly thinner and weaker. The physicians questioned them but got no answers, as they understood only their provincial dialect. Some one was found at length who could talk with them in that dialect, console them, and cheer them up, and the poor wretches visibly regained strength and hope. When all expedients have failed, and circumstances forbid the patient's return to his own country, there are still devices of stratagem that may improve his case. During the investment of Mayence the physicians sent word to the soldiers swept off by typhus and nostalgia that the general-in-chief had obtained from the besiegers a free passage for convalescents. The hope revived the courage of many among these unfortunates. Marceray cured a monk employed in a military hospital by making him read a fictitious letter containing permission from his superior to return before long to his convent. The case is the same with nostalgia as with other nervous affections, in which drugs are almost wholly powerless, and no im-

provement can be expected from other means than from skillful and judicious moral intervention on the physician's part. — *Revue des Deux Mondes.*

NOTE, BY THE EDITOR OF THE REVUE.—Circumstances have prevented the earlier publication of the foregoing sketch, which has been for some time in our possession. It is the last one sent us by one of our most sympathetic fellow-laborers, whom death removed suddenly and prematurely from his friends, the 2d of January, at the age of twenty-six.

THE ATMOSPHERE AS AN ANVIL.[1]

BY PROFESSOR J. P. COOKE, JR.

THE office of the atmosphere, as an anvil upon which rocks are shattered for the protection of humanity, has sufficient novelty about it to require explanation. It has come to be pretty well understood now that rocky fragments of all sizes are flying through space, like the planets themselves. What the effect would be, if hard meteoric stones were to strike, with a velocity sixty times as great as that of a cannon-ball, the structures that man builds upon earth, it is not difficult to imagine. To say nothing of the larger stones, no ordinary buildings could afford shelter from the smallest particles striking with the velocity of eighteen miles per second. Even dust flying at such a rate would kill any animal exposed to it. How effectually we are guarded by the atmosphere, as with a shield, impenetrable in proportion to the violence of the assaults upon it, is admirably illustrated by Prof. Cooke in the following statement, condensed from Chapter X. of his "New Chemistry:"

"Within a few years our community have become familiar with the name and terrible effects of a new explosive agent, called nitro-glycerine, and I feel sure that you will be glad to be made acquainted with the remarkable qualities and relations of this truly wonderful substance. Every one knows that clear, oily, and sweet-tasting liquid called glycerine, and probably most of you have eaten it for honey. But it has a great many valuable uses, which may reconcile you to its abuse for adulterating honey, and it is obtained in large quantities, as a secondary product of the manufacture of soap and candles, from our common fats. Now, nitro-glycerine bears the same relation to glycerine that saltpetre bears to caustic potash. Common saltpetre, which is the oxygenated ingredient of gunpowder, is called in chemistry potassic nitrate, and, although the commercial supply comes wholly from natural sources, it can easily be made by the action of nitric acid on

[1] Condensed from "The New Chemistry," Chapter X., "Gunpowder and Nitro-Glycerine."

caustic potash. My assistant will pour some nitric acid into a solution of caustic potash, and you will soon see crystals of saltpetre appear, shooting out from the sides of the dish, whose image we have projected on the screen. In a similar way we can prepare nitro-glycerine, by pouring glycerine in a fine stream into very strong nitric acid, rendered more active by being mixed with sulphuric acid—oil of vitriol.

"We could easily make the experiment, but you could see nothing. There is no apparent change, and it is a remarkable fact that, when pure, nitro-glycerine resembles, externally, very closely glycerine itself, and, like it, is a colorless, oily fluid—the reddish-yellow color of the commercial article being due to impurities. As soon as the chemical change is ended, the nitro-glycerine must be very carefully washed with water, until all adhering acid has been removed. The material thus obtained has most singular qualities, and not the least unexpected of these is its stability under ordinary conditions. After the terrible accidents that have happened, it would, perhaps, be rash to say that it did not readily explode; but I can assure you that it is not an easy matter to explode pure nitro-glycerine. It is not nearly so explosive as gunpowder, and I am told that the flame of an ordinary match can be quenched in it without danger, although I confess that I should be unwilling to try the experiment. Still, there can be no doubt that, under ordinary circumstances, a small flame will not ignite it. My knowledge of the matter is derived from Prof. Hill, of the Torpedo Station, at Newport, who has studied very carefully the preparation and application of the material. He is of opinion that most of the accidents which have given to nitro-glycerine such an unfortunate notoriety have been caused by the use of an impure article, and that proper care in its preparation would greatly lessen the danger attending its use. Nitro-glycerine is usually exploded, not by the direct application of heat, but by a sudden and violent concussion, which is obtained by firing in contact with it a fuse of some fulminating powder. The effects of this explosion are as peculiar as the method by which it is obtained, and I can best illustrate the subject by describing an experiment with nitro-glycerine which I witnessed myself at the Torpedo Station a few months since.

"It is so inconvenient to handle liquid nitro-glycerine that it is now usual to mix it with some inert and impalpable powder, and the names dualine and dynamite have been given to different mixtures of this kind; but in both of these the powder merely acts as a sponge. In the experiment referred to, a canister holding less than a pound of dynamite, and only a few ounces of nitro-glycerine, was placed on the top of a large bowlder-rock, weighing two or three tons. In order that you may fully appreciate the conditions, I repeat that this tin case was simply laid on the top of the bowlder, and not confined in any way. The nitro-glycerine was then exploded by an appropriate fuse fired from a distance by electricity. The report was not louder

than from a heavy gun, but the rock on which the canister lay was broken into a thousand fragments.

"This experiment strikingly illustrates the peculiar action of nitro-glycerine. In using gunpowder for blasting, it is necessary to confine it, by what is called tamping, in the hole prepared for it in the rock. Not so with nitro-glycerine. This, though it may be put up in small tin cartridges for convenience, is placed in the drill-holes without tamping of any kind. Sometimes the liquid itself has been poured into the hole, and then a little water poured on the top is the only means used to confine it. As an agent for blasting, nitro-glycerine is so vastly superior to gunpowder, that it must be regarded as one of the most valuable discoveries of our age. Already it is enabling men to open tracks for their iron roads through mountain-barriers, which, a few years ago, it would have been thought impracticable to pierce, and, although its introduction has been attended with such terrible accidents, those best acquainted with the material believe that, with proper care in its manufacture, and proper precautions in its use, it can be made as safe as or even safer than gunpowder, and the Government can do no better service toward developing the resources of the country than by carrying forward the experiments it has instituted at the Torpedo Station at Newport, until all the conditions required for the safe manufacture and use of this valuable agent are known, and, when this result is reached, imposing on the manufacturers, dealers, and carriers, such restrictions as the public safety requires. Of course, we cannot expect thus to prevent all accidents. Great power in the hands of ignorant or careless men implies great danger. Sleepless vigilance is the condition under which we wield all the great powers of modern civilization, and we cannot expect that the power of nitro-glycerine will be any exception to the general rule.

"But, while nitro-glycerine has such great rending power, it has no value whatever as a projectile agent. Exploded in the chamber of a gun, it would burst the breech before it started the ball. Indeed, there is a great popular misapprehension in regard to the limit of the projectile power of gunpowder, and inventors are constantly looking for more powerful projectile agents as the means of obtaining increased effects. But a study of the mechanical conditions of projection will show not only that gunpowder is most admirably adapted to this use, but also that its capabilities far exceed the strength of any known material, and the student will soon be convinced that what is wanted is not stronger powder, but stronger guns. I do not mean to say that we cannot conceive of a better powder than that now in use, but merely that its shortcoming is not want of strength.

"In gunpowder the grains of charcoal and nitre, although very small, have a sensible magnitude, and consist each of many thousand if not of many million molecules. The chemical union of the oxygen of the nitre with the carbon-atoms of the charcoal can take place only

on the surface of charcoal-grains; the first layer of molecules must be consumed before the second can be reached, and so on. Hence the process, although very rapid, must take a sensible time. In the nitro-glycerine, on the other hand, the two sets of atoms, so far from being in different grains, are in one and the same molecule, and the internal combustion is essentially instantaneous. Now, this element of time will explain a great part of the difference in the effect of the two explosions, but a part is also due to the fact that nitro-glycerine yields fully nine hundred times its volume of gas, while with gunpowder the volume is only about three hundred times that of the solid grains. There is a further difference in favor of the nitro-glycerine in the amount of energy liberated, but this we will leave out of account, although it is worthy of notice that energy may be developed by internal molecular combustion as well as in the ordinary processes of burning.

"The conditions, then, are these: With gunpowder we have a volume of gas, which would normally occupy a space three hundred times as great as the grains used, liberated rapidly, but still in a perceptible interval. With nitro-glycerine a volume of gas, nine hundred times that of the liquid used, is set free, all but instantaneously. Now, in order to appreciate the difference of effect which would follow this difference of condition, you must remember that all our experiments are made in air, and that this air presses with an enormous weight on every surface. If a volume of gas is suddenly liberated, it must lift this whole weight, which, therefore, acts as so much tamping material. This weight, moreover, cannot be lifted without the expenditure of a large amount of work. Let us make a rough estimate of the amount in the case of nitro-glycerine. We will assume that in the experiment at Newport the quantity exploded yielded a cubic yard of gas. Had the air given way instead of the rock, the liberation of this volume of gas must have lifted the pressure on one square yard (about nine tons) one yard high, an amount of work which, using these large units, we will call nine yard-tons, or about sixty thousand foot-pounds. Moreover, this work must have been done during the excessively brief duration of the explosion, and, it being less work to split the rock, it was the rock that yielded, and not the atmosphere. Compare now, the case of gunpowder. The same weight of powder would yield only about one-third of the volume of gas, and would, therefore, raise the same weight to only one-third of the height; doing, therefore, but one-third of the amount of work, say twenty thousand foot-pounds. Moreover, the duration of the explosion being at least one hundred times longer than before, the work to be done in lifting the atmosphere during the same exceedingly short interval would be only $\frac{1}{100}$ of twenty thousand foot-pounds, or two hundred foot-pounds, and, under these circumstances, you can conceive that it might be easier to lift the air than to break the rock.[1] . . . . .

[1] We here omit, for want of space, the beautiful explanation, afforded by the "New

"If there are some who have not followed me through this simple calculation, they may, perhaps, be able to reach clear views upon the subject by looking at the phenomena in a somewhat different way. It can readily be seen that the sudden development of this large volume of gas, which becomes at once a part of the atmosphere, would be equivalent to a blow by the atmosphere against the rock; or, what would be a more accurate representation of the phenomenon, since the air is the larger mass, and acts as the anvil, a blow by the rock against the air. It may seem very singular that our atmosphere can act as an anvil, against which a rock can be split, and yet it is so, and, if the blow has velocity enough, the atmosphere presents as effective a resistance as would a granite ledge. The following consideration will, I think, convince you that this is the case: I have here a light wooden surface, say, one yard square; the pressure of the air against the surface is equal, as I just stated, to about nine tons; but the air presses equally on both sides, and the molecules have such great mobility that, when we move the surface slowly, they readily give way, and we encounter but little resistance. If, however, we push it rapidly forward, the resistance greatly increases, for the air-molecules must have time to change their position, and we encounter them in their passage. If, now, we increase the velocity of the motion to the highest speed ever attained by a locomotive—say, one and one-fifth mile per minute—we should encounter still more particles, and find a resistance which no human muscle could overcome. Increase that velocity ten times, to twelve miles a minute, the velocity of sound, and the air would oppose such a resistance that our wooden board would be shivered into splinters. Multiply again the velocity ten times, and not even a plate of boiler-iron could withstand the resistance. Multiply the velocity once more by ten, and we should reach the velocity of the earth in its orbit, about twelve hundred miles a minute, and, to a body moving with this velocity, the comparatively dense air at the surface of the earth would present an almost impenetrable barrier, against which the firmest rocks might be broken to fragments. Indeed, this effect has been several times seen, when meteoric masses, moving with these planetary velocities, penetrate our atmosphere. The explosions which have been witnessed are simply the effect of the concussion against the aëriform anvil at a point where the atmosphere is far less dense than it is here. So, in the case of the nitro-glycerine, the rock strikes the atmosphere with such a velocity that it has the effect of a solid mass, and the rock is shivered by the blow."

Chemistry," of the molecular constitution of nitro-glycerine, and the transformations in its combustion, which account for the terrific force of its explosion.—Ed.

CREMATION AND ITS ALTERNATIVES.

By GEORGE BAYLES, M. D.

A SUBJECT upon which much earnest thought is concentred is, that method of disposing of the dead which shall be in strict accord with Nature's fixed intentions, and which shall not be delayed, by artificial means, to the obvious detriment of our plainest sanitary necessities. The only legitimate approach to a fair investigation of this subject is by the broad sanitary road. The obstacles are numerous and very serious by any other line of approach. There is a mountain of sentiment, of a very pronounced kind, on one side; a very formidable barrier of custom on the other; a rugged declivity of superstition in another direction, and a quagmire of indifference in another. To level all opposition of reason, prejudice, and superstition, is the work of the sanitarian. The chief appeal must be to that potent and first law of Nature, *self-protection;* and that law must be so proclaimed that, finally, a wholesome conviction shall take root in the popular mind that the sanitarian is right, and that every thing of a purely ethical and sentimental nature must yield to sounder views and practices than now prevail. This is, then, the true pathway to the right understanding of this subject.

Like all great reforms that have had their conception, their struggle for existence, and their ultimate triumph, any reform that contemplates so radical a change in the treatment of the beloved and respected dead is a work of time, and depends wholly upon an enlightened conception of the subject for its general recognition and popular development.

The placid, benign, and often spiritualized features of the recent dead, doubtless constitute a grave standing-ground of protest against the immediate reduction of the body to the dust and ashes to which the Almighty fiat has condemned it. There is something that savors of more than ignorant superstition in the commonly observed solemn hush in the presence of the body whose spirit has fled, in the superdelicate handling of the corpse by loving survivors, though with these manifestations of affection alone no sympathetic spirit would be inclined to quarrel. The scientific protest is not against the tribute of respect bestowed by sorrowing friends, let it be expressed in ever so many and ofttimes grotesque ways, while the body remains among the living, but, as it can so remain only a very brief period, the scientific protest is against all that in our modern times and civilized communities follows the social leave-taking of the dead.

No available progress can be made in moulding public taste and opinion upon this subject until scientific men are prepared to offer some economical and effectual method which shall be decorous and

quick for reducing the body to the minimum of material bulk—in a word, to ashes or dust. No methods yet advanced and advocated could be of universal adaptability, for the one simple reason, if no other, that they have highly-technical features of manipulation that could not commonly be commanded. The great problem will be how to make the reduction at once a funeral ceremonial, rapid in execution, and very commendable to those who are bereaved by death. It is especially noticeable that the popular ideas have insensibly gravitated toward the burning of the dead, as the only sure and perfect method of consuming the mortal remains. It is also especially noticeable that cremation, though not without a very ancient history, has never been perfected as a process for the reduction of animal bodies to ashes. Such specimens as I have seen, after repeated experiments by this method, have not been ashes, but cinders and scraggy clinkers. Neither were they generally white, but gray and discolored. Even in ancient times, descriptions of the "*assilegium*," or gathering of the bones and ashes, also washing, anointing, and depositing them in urns, prove how imperfectly the combustion and calcination had been effected.

Dr. Brunetti's failure to burn the human body, after many hours of earnest effort, and a resort to breaking, by mechanical force, the bones and other hardened tissues, evidently inspired Prof. Reclam, of the Leipsic University, with a determination to solve this seemingly difficult problem. His efforts were rewarded with success. The body was perfectly consumed, by heat alone, in twenty minutes, at a cost of less than three dollars, though the apparatus, of course, was expensive. An approved apparatus would, however, serve an indefinite number of cases.

In the interests of sentiment, personal preferences, and economy, why might not scientific men suggest other ways of reducing the dead body than by means of fire? Has modern chemistry no resources? Have our electrologists no practical ideas to present? Why could there not be a lithological transformation of the dead, and a subsequent aqueous or chemical dissolution? Why may there not be a system of thorough desiccation, and subsequent pulverization?

Now, for the sake of illustrating our idea of a lithological transformation, suppose we were to submit a body to such chemical action as would convert it into one of the compounds of carbon; say, for instance, carbonate of calcium, or carbonate of magnesium, or possibly one of the hydrated compounds of carbon with calcium or magnesium. Of course, our product, if it were a carbonate of calcium, for instance, would bear some relation and resemblance to calc-spar, marble, limestone of various kinds, and chalk; also the substance of egg-shells, the shells of mollusks, and (with the addition only of a trace of phosphorus), to the bones of our body. Thus, the whole mass of structural tissues would be practically ossified. If it were a hydrocarbonate of

magnesium, one product would be analogous (of course, not quite the same) to our magnesia alba of commerce. The formation of a mass of carbonate of calcium, not, however, possessing any degree of chemical purity worthy of mention, but sufficient for a specific mineralogical identification, and for the purpose of easy reduction to atoms by pulverization, deliquescence, or solution, would not be a difficult, expensive, or very tedious operation for the practical chemist. The reduction of the mass of carbonate of calcium into lime, and carbonic anhydride, would be a matter of the very easiest execution. It requires only heat to full redness in open vessels. In a current of air, or any gas, and especially of steam, the decomposition, or retrograde transition, takes place at a lower temperature. It requires no alteration of the principle in confining the process to the magnesium carbonates, or any other compound of carbon that may be mentioned. The hydrated carbonate, or ortho-carbonate, would differ from the carbonate less in principle than in the stage or point of extension of the process, and would be even more serviceable for one specific purpose, inasmuch as the product, at the ordinary temperature of the air, would crumble to a white powder, or, if quickly heated, would be converted into a pasty mass, which dries up to a powder. To effect this conversion of the body, which, at the outset of the operation, possesses the carbon element in sufficient abundance to be capable of almost any definite union under favorable circumstances, would require immersion in solutions which it would be easy to formulate and prepare, for any one under the inspiration of chemical experience and practical genius.

In a body weighing 154 pounds, not less than 110 pounds are water. Water, in any appreciable quantity, not becoming a constituent of our imagined *necro-lithos*, we see, at once, what an enormous reduction of bulk and actual weight the proposed process experiences. Therefore, no cognizance need be taken of the water of the body as a factor requiring special attention, its elimination being inevitable, and all the better, for it would have to be driven off by heat and evaporation, if it did not withdraw itself spontaneously. One of the peculiar features of the method is necessarily the spontaneous exclusion of the water—44 pounds of solid matter, then (in a body weighing 154 pounds), is exchanged for 44 pounds of calcareous stone of so non-compact a nature that it is peculiarly friable, peculiarly soluble, and wonderfully easy to dispose of. Carbon and water (or the elements of water), together with nitrogen, constitute about 98 per cent. of the whole weight of the human body. The nitrogen present weighs about 3½ pounds in 154, and to this is largely due the usual rapid decomposition. The suggested process of calcification would drive off nitrogen, together with about ten other very common chemical elements, existing in small quantities. The elements thus expelled rearrange themselves into ammonia, nitric acid, and other solu-

ble substances, and disperse themselves through the air, and fall to the soil for its enrichment.

The pith of the whole matter is this: Cannot the dead body be, by some chemical process, metamorphosed into stone, and then reduced to powder, for preservation, like ashes, in the funeral-urn, or scattered to the winds of heaven, to seek its normal starting-point for future transitions?

A NEW PROCESS FOR THE PRESERVATION OF WOOD.

By M. A. HATZFELD.

THE question of the preservation of wood, applied to the sleepers of railroads, telegraph-poles, and wood for mechanical purposes, etc., becomes from day to day more urgent, in presence of the increase of railways. Of all the materials employed until now, there remain hardly two in use—sulphate of copper and creosote.

The sulphate of copper gives only imperfect and very variable results. This we can easily understand: this very soluble salt must be in part diluted by rain-water and the humidity of the soil, so that, at the end of a certain time, the preservative effect has disappeared. Besides, this process very often causes alteration in the wood from the impurity of the salt employed, or from its acid reaction—circumstances which it is very difficult to avoid, when we operate on a large scale with materials containing, in a state of combination, an energetic acid, having for its base a metalloid, such as chlorine, sulphur, nitrogen, etc.

As to creosote, it is a substance comparatively rare, of a high price, of an inflammable nature, and, in consequence, difficult to transport and handle. Besides, and this perhaps is the most important consideration, it is a product which, like those we extract from fossil-coal, may, some day or other, in consequence of a discovery analogous to that of aniline, acquire a high industrial value. Its employment would then become impossible for the preservation of wood.

Hence we may say that these two substances do but imperfectly comply with the necessary conditions, and the question arises, whether there is no other material that might be used in all our present yards, i. e., that might be injected equally well by Boucherie's process (gravitative force of a heavy column of liquid), and by the modified process of Bréant (successive action, in a close tank, of a vacuum and of a pressure of several atmospheres). I propose the acid tannate of protoxide of iron, and base my views on the following considerations:

Wood, as we know, consists of cellulose, or cells in which there is

gradually deposited, as the timber matures, lignine, a hard concretion which makes up the greater part of the volume in hard woods, such as ebony, guaiacum, oak; in knots, the shells of nuts, etc. Wood, further, contains sap, which holds in suspension gummy materials, nitrogenous and albuminous substances, coloring-matters, etc.; these are the elements of decay in wood. Inasmuch as they offer to animal and plant-parasites an abundance of agreeable food, they undergo decomposition more or less rapidly, determining, by their own decay, the decay of all the other elements of the wood.

If we succeed in expelling these essentially putrescible materials, or fixing them in unalterable combinations, we thus prevent their decomposition, and, in consequence, that of the other more resistant organic substances, cellulose and lignine. A certain number of observed facts seem to demonstrate that the action of tannin upon vegetable tissues must be analogous to that which is exercised upon animal tissues—operating in the vegetable tissues a kind of tanning, which will have for result the formation of hard and imputrescible albuminous tannates, quite analogous to the gelatinous tannate products in the tanning of skins.

Thus, the sizing of wines is effected as well with the white of an egg (albuminous matter) as by isinglass (gelatinous matter). The tannic acid contained in the wine forms with either of these materials a solid net-work, which envelops and precipitates the lees to the bottom of the cask. An infusion of oak-bark preserves the skins of animals, and is also employed to protect from rotting the nets of hunters and fishermen. In fine, among exotic or indigenous woods, soft or hard, the most resistant are the richest in tannic acid, as among indigenous woods the oak and the chestnut; the first remarkably hard, the second soft enough, are both preserved during many years, and we cannot doubt that this is owing to the influence of the tannic acid with which they are impregnated, which, after the cutting of the wood, reacts upon the azotic and albuminous materials contained in their capillary vessels. We may therefore conclude that the injection of a solution of tannic acid into the various species of woods will assure their preservation, by putting them, in a chemical point of view, in conditions analogous to those in which we find the oak after it has been felled.

But it is not enough to protect soft wood from rotting; it must also be hardened; and though by the action of tannic acid we in some measure attain this end, the soft materials in the sap-vessels being transformed, still it is important that we should give to woods that are naturally soft a higher degree of hardness, in order to fit them for industrial uses.

I accomplish this object by the intervention of the remarkable property of tannate of iron, which, *perfectly soluble*, and even colorless, in a state of protoxide, is, under the influence of air, transformed

into an insoluble salt, of an intense black color. Dissolved in tannic acid to the condition of a soluble salt, in proportions which vary according to the degree of hardness to be given to the wood, it is rapidly transformed under the influence of air, and is deposited in the cells of the wood in a solid state, which it petrifies, so to speak, thus increasing the preservative effects of the tannic acid.

Thus we find resolved, in a manner simple and practical, the question of the introduction of an insoluble salt into wood. We may operate by injecting successively tannic acid, and then a soluble salt of iron; or, by means of a single operation, inject, sheltered from the air, the tannate of protoxide of iron, prepared in advance.

Results of experiments demonstrate the efficacy of this system. In fact, we frequently find in ferruginous soils very old oaks of a black color, and in a state of perfect preservation. I will cite an example that is quite remarkable.

In 1830 there were found at Rouen pieces of oak-wood, from some piles of a bridge built in the year 1150. This wood resembles ebony, of which it has acquired the hardness and the color. Chemical analysis has demonstrated that this modification was owing to the presence of tannate of peroxide of iron (Berthier). Argument and experience, therefore, agree in deciding in favor of the process which I propose.

The bark of most trees, the young branches and leaves, especially of the oaks, birches, elms, sumacs, chestnuts, and walnuts, the roots of the tormentil, and snake-weed, the green shells of horse-chestnuts, and the extracts of exotic woods, contain a large proportion of tannin, to which they owe their astringent properties.

THE FIRST COST OF THE MATERIALS USED FOR INJECTION.—In the present state of industry, we can procure tannin at one franc, at most, per kilogramme, in the form of extracts of wood that are employed in dyeing; but we may remark that these products, employed now only for dyeing and tanning, utilize only a very small quantity of the resources of the vegetable kingdom. There is no doubt that a considerable consumption of this product would lead to the establishment of numerous factories, principally in the poor regions, where chestnut and other suitable kinds of trees occur. The industrial wealth of the country would thus be augmented, and, at the same time, the price of this new product would be considerably reduced. Even at the present price, six hundred grammes being sufficient for the injection of one sleeper, the cost of the tannic acid would not exceed $\frac{60}{100}$ of a franc per sleeper. As to the salts of iron, they are so low in price that it is hardly worth while to estimate their cost. The salts of the protoxide of iron, soluble in tannic acid, carbonate, sulphate, protochloride, and pyrolignite, are easily procured or prepared. The pyrolignite, which seems the most convenient, is worth twenty francs the hundred kilogrammes, and, at a standard of 20° Baumé, contains about seven per cent. of iron. Of this, tannic acid neutralizes twelve

per cent. of its own weight, and, if we adopt, for the normal product to inject, $\frac{1}{8}$ of tannic acid and $\frac{1}{8}$ of tannate of protoxide of iron, the cost would amount to from $\frac{5}{100}$ to $\frac{6}{100}$ of a franc, making, in all, an expense of $\frac{65}{100}$ of a franc per sleeper.

Trials of this process are at this moment in course of execution upon a grand scale, by the Railway Company of the East, and the Administration of the National Telegraphs, with the authority and coöperation of the Minister of the Interior.—*Comptes Rendus.*

SKETCH OF PROFESSOR HELMHOLTZ.

By G. A. F. VAN RHYN.

GERMANY assembled in 1869 her greatest *savants* to celebrate the centenary anniversary of the birth of Alexander von Humboldt, her greatest dead. The highest honor of this occasion was bestowed on Prof. Helmholtz, who delivered the opening oration. He reviewed the progress made in the natural sciences with special reference to the labors of German students, and said: "In Germany there has always been a greater fearlessness of the consequences resulting from speaking the whole truth than anywhere else. The eminent *savants* of England and France are still obliged to bow to the dictates of social and ecclesiastical prejudices, and, when they speak openly, they do it to the injury of their social standing. Germany is bolder; she confides in what has never proved false—that the whole truth is the best remedy for the evils of truth imperfectly stated."

The Academy of France lent new force to his statement by refusing to elect him a corresponding member, on account of the advanced ideas connected with his name. A French critic rebuked his countrymen for hesitating to bestow on Helmholtz, the greatest living physicist of this century, so slight an honor, with the remark: "For his glory nothing is wanting; but he is wanting for ours." The Academy elected him in the following year.

Hermann Ludwig Ferdinand Helmholtz was born August 31, 1821, in Potsdam, the Prussian Versailles, the town of palaces, which gave birth to Alexander von Humboldt, and holds the ashes of Frederick the Great. His father was a teacher at the gymnasium in Potsdam, and a man possessed of a great store of knowledge. Under his guidance Hermann was soon prepared to enter the institution, where, as usual, too much Latin and Greek was taught for his youthful taste. He was, however, not permitted to shirk any of his studies, and, with that patient perseverance which is a dominant trait in his character, he ran through the whole curriculum of the gymnasium before he had

reached his seventeenth year. He then went to Berlin, and entered the military school of medicine known as the Frederick William Institute, or as the *Pépinière*. It is true that, if medicine was the study of his choice, there were ample facilities for it at any German university. But there were reasons which rendered it advisable to send him to a military institution. Prussia demands of all her sons several years of active service in the army, to begin when they are twenty-one years of age. This regulation provides her with large available forces, but sadly interferes with the pursuits of the young men at a time when the foundation must be laid for their future career. To overcome this difficulty, and to create at the same time a comparatively cultured army, it is provided that those who attend for a short period some military institution, and pass a satisfactory examination of a certain literary grade, shall be more or less exempt from active service in time of peace. Young Helmholtz's parents considered it best that he should avail himself of this provision at an early age, in order to insure for him an uninterrupted season of study in subsequent years. But Hermann had also his own reason for entering the military school of medicine. He had been seized with that martial fever which is apt to attack the youth of countries where there is continually a gaudy display of soldiers.

He went to Berlin, and on the three years which he spent there Helmholtz still looks back as the most pleasant of his life. There were strict rules to be obeyed, and there was hard study to be done; but there were also short furloughs to be obtained for rambles through the city, and some even long enough for a journey to the old home at Potsdam. The constant feeling of being on duty developed in him that noble manliness which so deeply marks every feature of his face.

When he was twenty, he graduated from the Pépinière with an article prepared for his examination marked with all the learning that he has since made his own. His dissertation was on the subject of the nervous system of invertebrate animals, and is the only morphological investigation which he has ever made.

His treatise evinced such uncommon ability that he was at once ordered to attend as assistant surgeon the hospital of the *Charité*, in Berlin, and after a few months he was promoted to the rank of physician in a regiment of hussars, stationed at Potsdam. This was wise, as it placed the youth again under the wholesome restraints and the kindly influences of the family circle, instead of allowing his hard-earned knowledge and well-trained *physique* to run to waste, like those of most young officers.

Helmholtz published in the same year the first fruit of his independent researches. It was an article on the nature of fermentation, which contains several remarkable suggestions on the subject of spontaneous generation. The excellence of this production opened to him the pages of the prominent medical magazines, and gave him the

honor of an engagement as contributor to the "Berlin Encyclopædic Lexicon of Medical Sciences." The most important among the numerous articles which he wrote during this period is one on the chemical analysis of the consumption of matter by muscular action; another on animal heat, especially in relation to the question whether the body of an animal throws out the same amount of heat which is produced by the combustion and transformation of its food; and a third, which treats of the development of heat through muscular action.

The great variety of subjects treated in his short publications during these years excludes the hypothesis that there was in his studies a gradual growth toward the discoveries which uphold his world-wide fame, and for which every branch of study related to the physical sciences is so greatly indebted to him. There are, however, impressions which every reader of these papers receives. Helmholtz is nobody's pupil; he stands on the basis of personal observation, and speaks whatever he believes to be true. To show how independently his mind was developed, it may be stated that he could not be induced to attend a single lecture on physical science while a student in Berlin.

In 1847, being consequently only twenty-six years of age, he published his important work, "The Conservation of Force." The discovery of this principle of Nature has been of the greatest moment to the progress of the whole range of physical sciences. This law is, in fact, indispensable to a sound understanding of any and every phenomenon in the animate and inanimate world. And Helmholtz opened his scientific career with a production that would have worthily closed a long life of study and fame.

After the publication of "The Conservation of Force," he was appointed prosector at the Anatomical Institute in Berlin, where he remained about a year. In 1849 he was called to the chair of Physiology at the University of Königsberg. He accepted it, and filled it for a period of nearly six years, in which he made some brilliant discoveries and inventions, which have proved a blessing to thousands of sufferers.

It had been generally held that the time needed for conceiving a thought, and experiencing sensations, could not be measured. Prof. Helmholtz (1850–'51) invented, however, a series of highly-ingenious processes for measuring the duration of any action, however swift, and demonstrated, in a number of papers, that there is a lapse of time before a sensation caused on one end of a nerve is felt at the other. He proved, for example, that, when we touch a thing, it takes a little time before we know that we touched it, and that, however rapid and seemingly instantaneous our actions be, some small period of time must elapse before we can begin to execute the mandates of our will. In 1851 he invented a mirror with which to examine the retina of the eye in living beings, and in the following year he described an

ophthalmometer, or an instrument for measuring the eye, which has proved of much service. His next researches were on the field of spectro-analysis, and he demonstrated that the results obtained by painters in mixing colors do not correspond with those of mingling the pure spectral colors of solar light or of other lights decomposed with a prism. He showed, for example, that, when yellow and blue rays of light are combined, the color produced is white, and not green. In connection with this subject, he entered into an admirable analysis of the extent and limits of human observation, and totally refuted at the same time Sir David Brewster's alleged decomposition of solar light.

In 1855 Helmholtz was called to the University of Bonn as Professor of Anatomy and Physiology, and director of the Anatomical and Physiological Institute. Three years later he removed to the University of Heidelberg, to fill a chair of Physiology, which he continued to occupy for more than twelve years. It would be tedious to enumerate every thing that his patient labor and the unerring logic of his mind demolished, while there, in the snug but shaky edifices of conservative science. He scattered the results of his researches with a liberal hand all over Germany. Every scientific periodical was honored by him with a contribution on its own specialty. There is, however, one class of his articles that appeared during this period which must not be overlooked. He had rendered valuable services toward an exact understanding of the mechanism of the eye, and had observed the physical laws of vision. He now turned his attention to a subject of equal importance. He investigated the mechanism of the ear, and searched for the laws of sound. His discoveries are laid down in his "Doctrine of the Sensations of Sound, as a Physiological Basis for the Theory of Music." It contains a complete analysis of the conditions of harmony, and reduces its æsthetic principles to a few fundamental physical laws.

Helmholtz's new doctrines of sight and sound have been universally received, and his fame will last as long as they continue to be among the main pillars of physical science. His name is also inseparably connected with the doctrine of the conservation of force, which subsequent investigation at the hands of others has shown to be the key-note of every law of Nature. Its bearing on the doctrine of evolution is, however, so strong and favorable that, like that doctrine, it will need much time before it receives an unreserved acceptance. Helmholtz tested, a few years ago, the progress which the doctrine of evolution has made, by asking the congress of natural philosophers, assembled at Speier, to declare, openly, who of them were in favor of, and who against, Darwinism. The roll was called, and there was not one against it. Helmholtz removed, in 1871, to Berlin, and holds there a professorship in the University.

CORRESPONDENCE.

INSURANCE VALUE.

To the Editor of the Popular Science Monthly:

IT is one of the most difficult things to popularize mathematical science, either abstract or applied. On this account, and not for want of good intention, I have failed, in my "Politics and Mysteries of Life Insurance," to make myself understood on some points, even by my able and candid reviewer in THE POPULAR SCIENCE MONTHLY for May. The reviewer says: "If the holder of a 'single-premium policy,' having twenty or more years to run, becomes desirous to surrender his policy at the end of five years, he should get back from the company, not only the 'reserve,' but also that portion of the 'insurance value' that has been set apart by the company to compensate for the risk attached to the remaining fifteen or more years of the policy's term."

This, I regret to be obliged to say, is not quite correct. But I must confess it is not an altogether unnatural inference from the definition of "insurance value" given on page 12 of "Politics and Mysteries." "Insurance value" is there spoken of *as if* it were a sum "paid in advance." It is really only a *function* of the sum so paid, not a part of it. The "single premium," apart from the margin added to defray office expenses, that is, the *net* single premium, is itself the reserve. The cost of the first year's insurance, so far as it is done by the company, comes from the *interest* of that premium. It is the present value of so much of the interest as is not needed to make up the "self-insurance" or reserve at the end of the year. And this reserve is the net single premium at the party's present age. And just so comes the cost of the next year's insurance, so far as it is done by the company. The "insurance value" of the policy at the start is the present value of all these costs, or partial interests, discounted both by the interest and mortality rates. Consequently it is nothing to be returned in addition to the reserve. On the contrary, if the life is a good one, which may be expected to live long enough to pay more than the average toward death-claims, something must be deducted from the reserve, which will bear some proportion to the "insurance value" of the policy at the time of surrender, to compensate the company for the loss of the *future wherewith* to make up the deficiencies of lives that are not good. This is on the principle that, other things being equal, the profitableness of policies will be as their "insurance values."

If we speak of "insurance value" as being actually contained in the single premium (net), then the balance thereof is less than the "self-insurance" or reserve. We have no technical name for that balance. Prof. Bartlett calls it (*see* "Politics and Mysteries," page 73), the fund which "works at compound interest till it amounts to the sum assured." But it is more, as will appear presently.

The two new technical terms "self-insurance" and "insurance value," which I have felt obliged to introduce into the discussion of this subject, cannot be well understood without noting their relation to each other.

Self-insurance is the amount in the hands of the company at the end of a policy year, which the insured party has paid beyond the normal cost of the past insurance. In the fact of paying so much beyond the normal or assumed cost, he insured himself to that amount. And the law has stepped in and made it emphatically a self-insurance, by virtually forbidding the company ever to apply it to the payment of a claim on any other policy.

Insurance value—and I should have done better by so defining it—is the present value, discounting by the assumed rates both of interest and mortality, of which the policy *may be expected* to contribute toward the payment of death-claims, including its own, so far as that, when it occurs, shall not be self-insured.

This "insurance value" has of course nothing to do with the margin arbitrarily

added to the net premium to defray working expenses, etc., nor with the excess of interest that may be realized on investments over the assumed rate. It would be a very extraordinary emergency indeed in any well-established company that would call these into requisition for the payment of death-claims, and, when not required for expenses, they are returned annually as surplus in mutual companies. It is strenuously argued that, because they *may*, if necessary, be used for the payment of claims, they should, along with insurance-value as above defined, be taken into account in fixing the maximum "surrender charge." But, as their discounted values, reduced by the improbability of their requisition for company use, would not materially differ in proportion from the insurance values, the argument for taking them into account is a good deal more nice than wise.

As the surrender value which can be fairly and wisely stipulated to be paid, if not paid when not stipulated, is a matter of great practical importance, let me explain particularly the case put by my reviewer of a single premium endowment insurance for twenty years, to be surrendered at the end of five years. If entered at forty, by the actuary's table, at four per cent., its net single premium would be $511.15 for $1,000. At the age of forty, the natural net premium to insure $1,000 for one year is $9.96. This, at four per cent., will amount at the end of the year to $10.36, so that the company, exclusive of the party himself, by insuring $1,000, runs the risk of losing $989.64 if he dies, and of gaining $10.36, if he does not. There is in this case no reserve at the end of the year, and no occasion to use the term "self-insurance." But if $511.15, which at the end of the year will amount to $531.60, it runs the risk of losing only $468.40. And, if in the former case the company may properly be said to have insured $1,000, in this it insures only $\frac{468.40}{989.64}$ $1,000=$473.31. For this insurance the party paid in advance (by part of his interest discounted) at the same rate as for the $1,000 in the other case, that is $\frac{473.31}{1,000}$ $9.96=$4.72 nearly. But if he had died during the year, his heirs would have received $1,000, the same as in the other case. Therefore, since the company insured only $473.31, the party himself must have insured the remaining $526.69; and this is precisely the reserve which, in Massachusetts, the law requires the company to show on hand at the end of the year, if the party is then alive, as the sum necessary under the assumptions to enable it to carry through the remaining nineteen years of the contract. Hence, the whole of the *insurance* operation of the first year, under this contract, is, that the company, exclusive of the party himself, will lose $473.31 if he dies, and gain $4.90 if he does not. The amount of the $511.15, after deducting the $4.90, which belongs to the company in case of survival, to pay other death-claims with, is a mere deposit held in trust, subject to the terms of the contract and the provisions of law.

If, having paid $4.72, the normal cost of the first year's insurance, we find those of all the succeeding years and discount them back to the start by both the assumed interest and mortality, their sum will be what I call the "insurance value" of the policy at its inception—"the sum which, paid in advance, under the assumptions, would exactly pay for all the insurance which the company is to do under the policy, as distinguished from what the party is to do himself."

Now, if we conceive that this sum, which in this case is $50.42, is a part of the $511.15, the balance, $460.73, is less than what will make the self-insurance or reserve required at the end of the year, and it is more than a sum which "works at compound interest till it amounts to the sum assured" at the end of the term. That would be only $456.39. The truth is, that the $50.42 is not a part of the sum in hand, but one of its functions. The complementary function, exhausting the power of the sum, is the $460.73—the "insurance value" of the self-insurance, so to speak, including in the self-insurance the endowment. The endowment, as will easily be perceived, becomes self-insurance, by assuming, what is the same to the company, that the party, if he lives to enter it, will be *sure to die* in the last year of the term.

If there were any practical utility in it, we might analyze the premium into three functions: the insurance value of the insurance by the company, the insurance value of the self-insured, and the endowment-value function, making, in the present case, $511.15=$50.42+$135.97+$324.76.

At the end of five years, in the case of this policy, the reserve or self-insurance is $595.82, and the "insurance value" is reduced to $37.90. According to the absurd rule, imported from England, no regard is had to "insurance value" withdrawn, but only to reserve, and the "surrender charge" is from one-third to two-thirds of the latter. Of course, no one would think of sacrificing a "paid-up" policy at such a rate. Prof. Bartlett recommends that in this case the company should deduct the entire "insurance value" and pay $557.92 as the "surrender value." My own opinion is, that eight per cent. of the "insurance value," or $4.03, is a sufficient charge to keep the company whole. This charge of eight per cent. is based on two assumptions, either of which seems to me reasonable: First, that the members who will select themselves out of a mutual company will not be collectively as much as eight per cent. better than the average. Secondly, that eight per cent. of the "insurance value" deducted from the reserve will be more than sufficient to replace that withdrawn with others as good.

ELIZUR WRIGHT.

BOSTON, *April* 22, 1874.

EDITOR'S TABLE.

THE CENTENNIAL CELEBRATION.

HOW shall this nation behave itself when it comes to be a hundred years old? Something extraordinary must be done to signalize that event. For we are a great people, spread over a great continent, on which are great lakes and rivers, and prairies, and coal-fields, and copper-mines; and we have had a great war, and got a great debt and a great common-school system, and how shall we *pose* in a manner befitting all this greatness when the nation has come to be as old as a very old man? To be sure, a large proportion of this greatness affords no very obvious ground of self-exaltation. The vast continent, with its mighty resources, we certainly did not make, and have got possession of it by means that are not greatly creditable, while neither a great civil war nor a great debt growing out of it is a thing to be much boasted of in this age of the world. Nevertheless, our people do not care to discriminate very nicely in this way; they have got a "big thing" in hand, and manifestly a great destiny before them; and by much contemplation of these things they have engendered a self-consciousness of greatness, which it is calculated will reach the exploding point by the Fourth of July, 1876. What manner of demonstration will befit that occasion is now the perplexing question.

The special event to be commemorated is undoubtedly political. The act of severance by which we established our national independence was a political transaction. We refused any longer to accept a foreign rule, and decided to shape our own government and do our own governing. We worked out a measure of political reform by laying down the simple principle that the people living here are better judges of what they want than people on the other side of the world. It was a step of rational advance in the management of public affairs, and was significant not so much for any vast or absolute good immediately attained, as for opening the way for other and better things in the future. We abandoned monarchy and a state Church, toggled up an arrangement called the Constitution, and entered upon the experiment of shaping civil institutions in accordance with reason. After

a hundred years of trial, we find ourselves called upon to make report of the net results of our experiment. What and how much have we done to make humanity our debtors? How have we used our opportunities? How much has been gained toward the progress and welfare of man by our experience? The Centennial Celebration should be the suitable occasion to return answers to these questions.

Obviously it will not do merely to carry out John Adams's old programme of bell-ringing, powder-wasting, and hosannas to liberty, by raising the Fourth of July, 1876, to the tenth power of uproar and rhetorical bombast. And, although the event to be commemorated is political, nothing could be more absurd than to go into a paroxysm of political jubilation. If politics alone is to be taken into account, there will be precious little to celebrate, for it is matter of world-wide notoriety that the course of the nation has been downward in this respect from the start. British rule had given us better men in 1776 than a century of republican experience can turn out in 1876. In purity, honor, self-sacrifice, and the triumph of patriotic principle over selfish ambition, the politicians of to-day will bear no comparison with those who founded the government a hundred years ago. If we are to be judged solely by the political fruits of our political system, it would be most appropriate to devote the Centennial to fasting and humiliation, with the accompaniments of sackcloth and ashes.

But, if technical politics has degenerated and fallen in esteem, there has been a noble progress in other directions and in other things, involving the thought and life of the people, which may well be commemorated on our centennial birth-year.

The act of severance which made us an independent people, as we have said; was a measure of government reform in the direction of less government, or a restriction of its powers and offices. There was an increase of self-government at the expense of state control, under the theory put forth by the author of the Declaration of Independence, that "the world is governed too much." By declaring at the outset, that the source of power is not in the divine right of hereditary rulers, but among the people themselves; that religion is not a fit matter for the state to deal with, but must be left to individuals; and by organizing a political system, in which the management of their own interest was thrown back upon the people by local and municipal regulations, while the powers of the General Government were strictly limited and defined by a written constitution, a new order of things was theoretically assumed and partially adopted, which, if carried out, could not fail greatly to narrow the sphere of legislation and reduce the pretensions of politics. The preamble to the Constitution, which declares the reasons why our government was established and the principles which should animate and pervade all our legislation and administration, though couched in general terms, if fairly construed and thoroughly executed, would work the most profound and beneficent reform that could be conceived in the conduct of civil affairs. It would strike away half the machinery of political regulation, and raise the other half to a double efficiency and power. The founders of our government declared that it was ordained to "establish justice," and if the state were confined to that great duty, and the whole moral power of the community were concentrated upon the attainment of that result, the thousand other things with which government now meddles might safely be let alone. The practical working of our political system, it must be confessed, has fatally contravened the intentions of its founders; and, in the attempt to attain a multitude

of illegitimate ends, justice, instead of being established, is sacrificed. Nevertheless, by all the implications of the theory upon which we started, politics was to be increasingly circumscribed, and the community left more and more to self-regulation, self-development, and the course of private enterprise. And, happily, political meddling and interference have not been able to defeat this powerful tendency of things. There has been a progress of intelligence, a liberalization of ideas, a promotion of welfare and an improvement of the social condition, which are to be credited, not to politics, but to the laws of human nature and the spontaneous agencies of social life. It is our accomplishment in these directions that we think may be most fitly marked and commemorated in the approaching Centennial.

One of the grandest achievements of the past century is the victory that has been gained over the old spirit of national narrowness and jealousy by which all foreigners were regarded as enemies. Increased inter-communication through the extraordinary modern facilities of travel, and a more familiar acquaintance with the internal life of other countries, have dissipated much of the hostile feeling which was formerly fostered as one of the first duties of patriotism. Commerce has aided to break down international prejudices, and the interchanges of thought and a common interest in the discoveries of science and the inventions of art, by which human condition is ameliorated, are still further favorable to the sentiment of unity among the family of civilized nations. International bigotry is of course very far from being extirpated, and is still available to the demagogue, but it has been greatly diminished. Man is certainly becoming more by virtue of his manhood, and less by virtue of his nationality. It may safely be affirmed that, if the feelings of different peoples could be consulted, and if it were not for the machinations of politicians, international wars would in future be impossible. It may be long before this feeling of sympathetic regard and the duty of justice toward strangers will become sufficiently strong to rule the policy of governments; but that it is increasing in influence is a pronounced and hopeful tendency of modern times, and it should be recognized and strengthened in all possible ways and on all practicable occasions. For these reasons it seems in the highest degree proper that the celebration of our hundredth anniversary should have an international character. To shut ourselves up in surly exclusiveness on our centennial birth-year, and endeavor to revive the illiberal moods and disagreeable memories of a century ago, would be to violate the spirit of the occasion, and, as the phrase is, to "go back" on the best work of humanity for the last hundred years.

Another great result of civilization during the past century, and in which this country has had a conspicuous share, is the development of the arts, the multiplication of inventions, the progress of industry, the extension of science, and that conquest of material Nature which gives new advantages to all ranks of society. In this race of constructive and pacific improvement we are the competitors of other nations, while each type of people makes contributions in accordance with its own genius and circumstances. In the multiplicity and ingenuity of our devices, and in their adaptation to the practical wants of mankind, this country need not be ashamed of its position. It has been long perceived that great mutual advantage would result to different nations, and an immense total gain to civilization, by bringing into close comparison the best that each community has to offer in the way of artistic and industrial productions. England, France, and Austria, have instituted international exhibitions, and invited the coöperation of the world

to make them in the highest degree instructive. Why should the United States not join in this generous rivalry, and make an International Exposition the chief feature of its Centennial Celebration? A project of this kind has been ably devised and thoroughly matured; it is to be hoped that a people so full of great things will not break down in its execution under such memorable circumstances, and especially after the enterprise has gone so far as to implicate the national honor.

A CHEMICAL CENTENNIAL.

And, as centennials are now in order, we are happy to see that there is beginning to be a stir in behalf of a Scientific Centennial Celebration for the present year. Dr. H. Carrington Bolton, of the School of Mines in Columbia College, has written a letter to the *American Chemist*, stating that the year 1774 was so memorable for the number and importance of its chemical discoveries, that it may with good reason be regarded as the birth-year of the science. It was in that year, he states, that the Swedish chemist Scheele first isolated chlorine and threw important light upon baryta and manganese. Lavoisier's experiments upon tin, which led to subsequent discoveries of immense importance, were made also in that year. Dr. Bolton says: "Wiegleb proved alkalies to be true, natural constituents of plants. Cadet described an improved method of preparing sulphuric ether. Bergman showed the presence of carbonic acid in lead white. On the 27th of September in this year Comus reduced the 'calces' of the six metals, by means of the electric spark, before an astonished and delighted audience of *savants*. On the 1st of August, 1774, Priestley discovered oxygen, the immediate results of which were the overthrow of the time-honored phlogistic theory and the foundation of chemistry on its present basis. It surely requires no lengthy argument to prove that the year 1774 may well be considered as the starting-point of modern chemistry."

In commemoration of these discoveries, Dr. Bolton suggests that "some public recognition of this fact should be made this coming summer. Would it not be an agreeable event if American chemists should meet on the 1st day of August, 1874, at some pleasant watering-place, to discuss chemical questions, especially the wonderfully rapid progress of chemical science in the past hundred years?"

We think this suggestion excellent, and hope it will be carried out. Fortunately the date is favorable, as it occurs in the season of general vacation. We suggested some time ago that such a centennial as this ought to be celebrated; and, as the great discoverer of oxygen was exiled to this country by foreign intolerance, and died here, we proposed to erect a statue to him in the Central Park. But monuments to scientific men are not yet much in favor. They erected one to Dr. Jenner, the discoverer of vaccination, in Trafalgar Square, London; but the place was wanted for a military hero, and so the Jenner statue was carted away to an obscure place in Kensington, and planted down by the public water-filters. He, whose discovery had saved more lives annually than the collective armies of Europe could destroy, if all put at their business, had to give place to one who had signalized himself in a small way, in the work of destroying his kind. Let the chemists meet and celebrate the birth and growth of their science; perhaps in another hundred years the turn of the discoverers will come.

"*RESPONSIBILITY IN MENTAL DISEASE.*"

Whatever may be said about the futility of "theories" and the importance of "facts," it is certain that we

can no more escape the use of the former than the recognition of the latter. Facts are nothing until they are brought together, compared, interpreted, and some view of them arrived at—and that is a theory. From the most trivial events in daily life to the grave and critical decisions of deliberative bodies, from the question of taking along an umbrella to that of the financial policy of the nation, or a declaration of war, action follows theory as the all-essential thing in the determination of results.

A tragedy has just been enacted in Boston, which affords an impressive illustration both of the importance of theories and the terrible evils that flow from the adoption of wrong theories. A year and a half ago a lad named Jesse Pomeroy was convicted of the atrocious crime of luring young children into by-places and gashing and mutilating them in the most cruel manner. He carried on this savage practice for months, operating upon no less than seven children, and was then taken up by the authorities. How to estimate his conduct, and what to do with him, was then the question. The nature of the acts that he had perpetrated, by their wanton and persistent cruelty, marked him out as not only an exception to the class of youthful offenders, but as an inhuman monster, wanting in moral sense and destitute of the common attributes of humanity. His conduct showed that he was abnormally and insanely constituted. That he was a deficient human being was just as evident as a matter of fact as if he had been born blind, deaf, or without arms. But the authorities proceeded upon another theory—they assumed that he was like other bad boys, and could be reformed, and so they sent him to the State Reform School. After remaining there a year and five months he was released "on probation"—five years before the time at which he would have been entitled to a legal discharge.

On the 22d instant "the body of a boy, four years of age, was found by the water-side in South Boston, bleeding from a multitude of wounds. There were eighteen stabs in the region of the heart. The hands were cut, as if in the little fellow's attempt to ward off the blows of the murderer. The throat was slit, and one eye was nearly cut from its socket. Footmarks in the mud seemed to prove that the child had been led to the spot by some older companion, who must have lifted him down from the wharf, where the prints first appeared; and the condition of the body showed that the murder had been committed but a very little while before its discovery—that is to say, in broad day." Jesse Pomeroy was suspected of the deed, arrested, and confessed that he perpetrated it.

This case, shocking as it is, is by no means rare in its quality. The instances are numerous of individuals who have displayed a propensity for the apparently wanton infliction of pain and destruction of life. The life-destroying impulse may take the direction of suicide, or be turned against others, and frequently manifests itself as an ungovernable propensity to kill infants and young children; and examples are not wanting in which persons are conscious of this terrible tendency in themselves, and, while still able to resist it, invoke restraint from others as their only protection. There is such a thing as insanity—a diseased condition of mind in which reason and self-control are destroyed and responsibility ceases. There cannot be a doubt that Jesse Pomeroy belongs to this class, and his first perpetrations of cruelty should have been held to establish this as absolutely as if his intellect had been shattered and he had been a raving maniac. If the theory at first acted upon, that he was soundly constituted, responsible, and capable of reform, be carried out, of course nothing remains but to strangle him in due form—and that is the short method which society generally

prefers, and which, while it appeases public indignation, disposes of the case, and is supposed to end all difficulty. But it is beginning to be seen that these summary procedures do not put things to rest. With every new instance of this kind we are again confronted with the perplexing problem of how far the defective-minded and badly-constituted are amenable to penalties that are prescribed to the mass of the community who are recognized as sane and responsible.

As we have said, insanity is a fact of human nature—troublesome to define, difficult to limit, and often hard to establish, but which must be met and dealt with as a stern reality. Obscure in its manifestations, profound and remote in its causes as it often is, we are liable to encounter it at any time, while it is so serious a thing that prompt and decisive public action is compelled to be taken upon it. Its questions arise continually in our courts, and have to be passed upon by juries of citizens, upon whose theories of the subject depend the issues of life and death. And besides these intrinsic difficulties in arriving at correct judgments regarding alleged cases of insanity, there are extrinsic difficulties more formidable still, for no subject is more overlaid with public prejudice than this. While such things as law, justice, civilization, and Christianity, have asserted their supremacy for thousands of years, it is only within recent times—so recent as to be still within the memory of men—that the system of atrocious barbarity by which the insane had been always and everywhere treated has been brought to a termination. But, while humaner feeling and increasing enlightenment have gained the victory, it would be idle to deny that much of the ignorance, prejudice, and superstition, which gave rise to the old order of things still continues. There still survive the instinctive distrust, antipathy, and repugnance, toward the victims of mental disorder, as though their calamity were a disgrace and reproach to the nature of humanity. With such lingering errors in the popular mind, combined with a lack of the information which science has furnished, it is not surprising that we should often witness outbreaks of public passion so vehement as to affect the administration of justice. The case of James Freeman is still fresh in the memory of this generation. He had murdered a whole family under circumstances of atrocity that ought at once to have raised the suspicion that he was not a sane man; and, when brought to trial in Syracuse, his appearance attested him to be a half-demented brute. That the State was saved from the disgrace of executing him as a responsible criminal was due not to the intelligence or humanity of the people of Central New York, but to the noble intrepidity of an eminent lawyer, who, with no hope of reward, faced a storm of public indignation by voluntarily undertaking his defense. The evidence of public prejudice in relation to this subjust is still further seen in the general impatience that is evinced when the plea of insanity is urged in capital trials. No doubt this plea has come to be a resource of lawyers, and is made the most of without regard to justice, in the defense of criminals; but the license of lawyers is a settled policy in the procedure of courts, and it is to be expected that they will strain and abuse every plea that can be made available. Moreover, as we have repeatedly said, insanity is a fact, and from its nature a cause of crimes the most inhuman; and while, in cases of suicide, mental derangement is alleged by coroners' juries as almost a stereotyped cause, it is not only proper but imperative to inquire if it may not also be a cause in cases of homicide. This plea is not to be ruled out or escaped as illegitimate; and the only rational course is to prepare to meet it and deal with it intelligently.

Technically, this subject belongs to physicians, as it is to their profession that we are indebted for our knowledge of it; and they are also the parties to whose intelligence and experience society must appeal in all obscure and doubtful cases. But the subject belongs, also, to the general public, in a far more important sense, for citizens not only have to share in legal proceedings in which insanity is involved, but they have to deal with it in its early stages and its private management. Nor is this all. As the past study of mental derangements, from the scientific point of view assumed by the medical man, has contributed largely to the extension of our knowledge of human nature, so there is no better method now of getting at that knowledge than by considering the aberrant and disordered manifestations of the human mind. It is quickly found that mankind are not to be sharply divided into two groups, the sane and the insane—the responsible and the irresponsible—but that these states pass into each other by degrees, so that men are to be judged, as it were, by their position upon a scale of organization, character, and opportunities. Dr. Henry Maudsley, a philosophic student of this subject, and a distinguished authority in the alienist branch of medical practice, has just prepared a valuable popular work[1] upon this question, which contains just the information that needs to be widely disseminated. The book is a compact presentation of those facts and principles which require to be taken into account in estimating human responsibility — not legal responsibility merely, but responsibility for conduct in the family, the school, and all phases of social relation in which obligation enters as an element. The work is new in plan and was written to supply a widely-felt want which has not hitherto been met. It may be strongly recommended to general readers, and, as the important truths it contains are not enforced in the prevailing system of education, it should be especially read by young men as a preparation for the duties and responsibilities of citizenship.

If any suppose that the questions considered in the previous article are not practical and pressing, we offer them an additional fact. Since it was in type, the State of New York has undoubtedly hanged an irresponsible maniac. Joseph Waltz was executed at Catskill, May 1st, for a murder so wanton and causeless as to raise a strong presumption of mental derangement, which was also confirmed by other circumstances. His keeper in the jail proceeded upon the same theory as that of the Boston authorities in the case of Pomeroy, and assumed that he was sane. He had been frequently cautioned against exposing himself to the murderer, but always answered, "Joe won't hurt me;" yet the day before his execution he broke his keeper's skull with an iron bar. The existence of homicidal mania is a well-recognized fact, and there was the strongest presumption that this was an instance of it. But, although the second attempt to kill tended to confirm the evidence of the first—that Waltz was of unsound mind—the Catskill people, it is said, turned out by thousands with the view of breaking jail and lynching him, so that the military had to be called on to prevent the crime of public murder. The only party who could have legally interfered to stay the execution until a more thorough inquest into the case might be had, was the Governor at Albany, elected by the help of the aforesaid mob, and, of course, "accountable to the people," and he did not choose to interfere.

Waltz's brain was examined by the physicians after his death, and reported free from disease. It was unusually

[1] "Responsibility in Mental Disease," by Henry Maudsley, M. D. (No. 9 of the "International Scientific Series"). 313 pages. Price, $1.50. D. Appleton & Co.

large, weighing fifty-four ounces, which is five ounces above the average. "The membranes and gray matter were found in a healthy state, and the convolutions were perfect. An incision disclosed no softening, and a critical examination failed to discover any organic malformation or disease." And it was therefore the opinion of the examiners that there was nothing in the organ to indicate insanity. Of this it may be said: 1. That a hurried examination, under such circumstances, of so delicate and complex an organ, and where the indications of morbidity are often most obscure, is not in the highest degree trustworthy; 2. That insanity may exist where dissection cannot detect the evidence of it in the cerebral tissues, as where it is due to a morbid condition of the blood; 3. If profound disease *had* been discovered in the organ, it would not have been held to prove insanity, and we should have been reminded of those cases in which extensive brain-disease has coexisted with entire sanity. We should have been further assured that the proof of insanity is not in the disclosures of the scalpel, but in the manifestations of conduct. The state of public feeling and intelligence is well indicated by the tone of some of the newspapers, which insist that maniacal murderers may just as well be hanged and got out of the way as other murderers. One of them says: "Had Waltz been a resident of this city he would not have been hanged, probably, but would have escaped on the plea of insanity. Fortunately, however, he is hanged and well out of the way; and we doubt not that society, in the light of such facts as his crime presents, will eventually come to the view that it must hang all murderers, sane or insane." In such a case, as another morning paper remarks, "if the maniac is hanged, it is highly desirable that he should be hanged as a maniac, so that the community and the asylums may know how they stand in relation to each other." An excellent suggestion, which might be carried out by doing this branch of the business in the State asylums for the benefit of the lunatics.

THERE has been much inquiry in this country for a good portrait of Herbert Spencer, and preparations have been, for some time, in progress to furnish it. Mr. Spencer was requested to sit for an oil-painting, and to select his artist for the work. He chose Mr. W. H. Burgess, of London, one of the greatest masters of expression in our time, and the work produced is regarded by Mr. Spencer, and by those who know him, as a remarkable success in portraiture. The portrait, which is now on exhibition at the Academy, has been, for several months, in the hands of H. B. Hall, jr., for the production of a large steel engraving suitable for framing. The print is an excellent likeness and an elegant work of art, and it will be the picture by which Mr. Spencer will be known to the future. A limited number of artist's proofs have been taken on fine India paper, price ten dollars, and those who wish to possess themselves of one of these impressions may do so by applying to the editor of THE POPULAR SCIENCE MONTHLY.

LITERARY NOTICES.

THE LAND OF THE WHITE ELEPHANT. Sights and Scenes in Southern Asia. A Personal Narrative of Travel and Adventure in Farther India, embracing the Countries of Burma, Siam, Cambodia, and Cochin-China (1871, '72). By FRANK VINCENT, JR. 316 pp. Price, $3.50. Harper & Brothers, New York.

THE perversity by which language becomes turned to the conveyance of false ideas seems to be as universal as it is inveterate: near home, the June magazines are published in May, and journals are issued once a quarter, while in Farther India the white elephant is as "black as a coal,"

and of half a dozen other colors. Human nature secretes the same incongruities wherever we find it. Frank Vincent has written, and the Harpers have published, a beautifully illustrated and most readable book about the people, the products, the cities, and the temples, of a vast tract of Indian country, known as the "Land of the White Elephant." In the course of his three years' journey round the world, the author of this volume spent eleven months in the "marvelously-beautiful countries," and amid the "strange people and stranger customs" of Farther India—a country of one million square miles and twenty-five million inhabitants, with a productive soil and extended commerce. After visiting every thing of interest in Lower Burma, the writer made an excursion up the great Irrawaddy River to Mandalay, in Upper Burma, or Ava—a distance of seven hundred miles. Mandalay, the capital, is a new city. It began to be built in 1855, and in 1857 the king and court adopted it as the royal residence, while it now has a population of one million. Let Chicago hide its diminished head in presence of the enterprise of these heathen. "The city proper is a square—a mile on each side—and is surrounded by a lofty and very thick wall of loose brick (unplastered) with a notched parapet, and having a broad and deep moat filled with clear water. There are three gates on each side, and macadamized streets about a hundred feet in width, leading from them, intersect the city at right angles; then, between these are small and irregular streets and by-paths. Along the sides of the larger avenues there run channels for carrying water (which is brought from the river in a canal fifteen miles long) throughout the city. Each gate-way is surmounted by a lofty, pyramidal-shaped wooden tower with the customary terraced roof, and, at irregular intervals, there are turrets, raised a little higher than the wall, and surmounted by small wooden pavilions of the same model as those over the great gates. We crossed the moat on a massive wooden bridge, and passed through one of the western gate-ways—the only one through which corpses are allowed to be taken from the city, as my guide observed. The gates are of enormous height and thickness, and are built of teak beams, fastened together with huge iron bolts." The author says, "I determined to make this trip, to pay my respects to his majesty the king." Accordingly, on his arrival in the city, through the favor of a Chinese resident who enjoyed the friendship of his majesty, he was granted an audience. The king seems to have taken a fancy to him, and offered him good business facilities and as many Burmese wives as he wanted, if he would stay and help him; but the virtuous young man said he would see his folks about it before deciding.

Inspired by his elephant-hunting curiosity, Mr. Vincent afterward visited the King of Siam at Bangkok, and discourses upon the condition of his elephants and the philosophy of the subject as follows:

"The first animal whose stable we entered was quite small, and possessed few of the peculiar characteristics of a 'dark-cream albino,' excepting perhaps the eyes. The keeper fed him with bananas, and caused him to make a *salaam* (a profound salutation or bow) by raising his proboscis to his forehead for a moment and then gracefully lowering it to the ground. In another shed we saw a larger and also whiter elephant, its body having the peculiar flesh-colored appearance termed 'white.' Here there was, besides, a white monkey—'white animals are the favorite abodes of transmigrating souls'—kept to ward off bad spirits, as the attendant informed us.

"Sir John Bowring—and he is about the only person who has written at length on this subject—in a very interesting 'chapter on elephants,' tells us that the Buddhists have a special reverence for white quadrupeds; that he has himself seen a white monkey honored with special attention. Also, that white elephants have been the cause of many a war, and their possession more an object of envy than the conquest of territory or the transitory glories of the battle-field. In the money-market the white elephant is almost beyond price. Ten thousand sovereigns (fifty thousand dollars) would hardly represent its pecuniary value; a hair from its tail is worth a Jew's ransom. 'It was my good fortune,' he says, 'to present (in 1855) to the first king of Siam (the Siamese have two kings exer-

cising supreme authority) presents with which I had been charged by my royal mistress. I received many presents in return; but the monarch placed in my hand a golden box, locked with a golden key, and he informed me the box contained a gift far more valuable than all the rest, and that was a few hairs of the white elephant. And, perhaps, it may be well to state why the elephant is so specially reverenced.

"Because it is believed that Buddha, the divine emanation from the Deity, must necessarily, in his multitudinous metamorphoses or transmissions through all existences, and through millions of æons, delight to abide for some time in that grand incarnation of purity which is represented by the white elephant. While the *bonzes* teach that there is no spot in the heavens above, or the earth below, or the waters under the earth, which is not visited in the peregrinations of the divinity—whose every stage or step is toward purification—they hold that his tarrying may be longer in the white elephant than in any other abode, and that in the possession of the sacred creature they may possess the presence of Buddha himself. It is known that the Cingalese have been kept in subjection by the belief that their rulers have a tooth of Buddha in the temple of Kandy, and that on various tracts of the East impressions of the foot of Buddha are reverenced, and are the objects of weary pilgrimages to places which can only be reached with difficulty; but with the white elephant some vague notions of a vital Buddha are associated, and there can be no doubt that the marvelous sagacity of the creature has served to strengthen their religious prejudices. Siamese are known to whisper their secrets into an elephant's ear, and to ask a solution of their perplexities by some sign or movement. And, most assuredly, there is more sense and reason in the worship of an intelligent beast than in that of sticks and stones, the work of men's hands.

"'And yet,' continues Sir John, 'after all, the white elephant is not *white*, nor any thing like it. It is of a coffee-color; not of unburnt, but of burnt coffee—dull brownish yellow, or yellowish brown—white only by contrast with his darker brother. The last which reached Bangkok was caught in the woods. The king and court went a long way out into the country to meet him, and he was conducted, with a grand procession, much pomp, music, and flying banners, to the capital. There a grand mansion awaited him, and several of the leading nobility were appointed his custodians. The walls were painted to represent forests, no doubt to remind him of his native haunts, and to console him in his absence from them. All his wants were sedulously provided for, and in his "walks abroad," when "many men he saw," he was escorted by music and caparisoned by costly vestments. His grandest and farthest promenades were to bathe in the river, when other elephants were in attendance, honored by being made auxiliaries to his grandeur. Now and then two sovereigns sought his presence; but I did not learn that his dignity condescended to oblige them with any special notice. But he wanted no addition to his dignity. Every thing associated with majesty and rank bore his image. A white elephant is the badge of distinction. The royal flags and seals, medals and moneys—on all sides the white elephant is the national emblem, as the cross among Christians or the crescent among Turks; and the Siamese are prouder of it than Americans, Russians, Germans, or French, are of their eagles, or Spaniards of the golden fleece. The Bourbon *oriflamme* and the British Union-Jack show but faintly in the presence of the white elephant.'"

WHAT IS DARWINISM? By CHARLES HODGE. 178 pages. Price, $1.50. Scribner, Armstrong & Co.

THE title of this book is a little misleading, although it cannot mislead very far when it is remembered that it emanates from a distinguished Professor of Divinity at Princeton College. A book that should plainly and clearly answer the question "What is Darwinism?" as a matter of pure exposition, and which should also state what it is not, would be extremely useful at the present time. But such a book could only be made by a man of science, free from prejudice, and familiar with the history and bearings of the whole question. The term "Darwinism" is now vaguely used to represent a whole body of

doctrines with which it is associated, and of which it is itself but a part; and a book, professing to answer the question implied in this title, should make the discrimination and dispel the vagueness. If the question were given with its ominous implications, as, "What is this horrible Darwinism?" the reader would be set on the right track by the title; for the book is actually an essay on the relations of Darwinism and orthodoxy, and its aim seems to be to establish the position that Mr. Darwin's theory excludes design in Nature, and is therefore atheistic. Dr. Hodge cites various authorities who hold to this view, and he cites others against it. He admits that Mr. Darwin recognizes the agency of the Creator in originating the first germs of life, and he says, "it is conceded that a man may be an evolutionist and yet not be an atheist, and may admit of design in Nature." And yet he is unwilling to let the matter rest here, and the drift of his book seems to be to show that the whole tendency of the inquiry is irreligious and pernicious. He could make out exactly the same case with the doctrine of gravitation as with the doctrine of evolution. The theory of Newton was objected to in its time as dispensing with God, and explaining the movements of matter by a self-sufficing law of inherent attraction. That question is passed by, and men are left at liberty to interpret it in the way they choose. Why not deal with evolution in the same way? The real question is, "What is the truth of the case?" and, until that is worked out and established, it is premature to complicate it with theological difficulties. Nothing is more certain than that it must be investigated by scientific men, on its own merits.

So acute and cultivated a mind as that of Dr. Hodge could not deal with the question without giving interest to it, and his book will well repay perusal. The author evidently aims to be just, and his volume is measurably free from the denunciatory spirit which is too characteristic of controversy. But it must still be said that he is evidently too little familiar with the subject, and some of his statements will surprise the well-informed reader. For example: "When the theory of evolution was propounded, in 1844, in the 'Vestiges of Creation,' it was universally rejected; when proposed by Mr. Darwin, less than twenty years afterward, it was received with acclamation. Why is this? The facts are now what they were then; they were as well known then as they are now. The theory, so far as evolution is concerned, was then just what it is now. How, then, is it that what was scientifically false in 1844 is scientifically true in 1864?" This statement of Dr. Hodge that the doctrine of evolution, as now understood, was propounded by the author of the "Vestiges of Creation" in 1844, is about as correct as the statement of Drs. Burr and Dawson, that it is a plagiarism from the old Greek atheists, Anaxamander, Anaxagoras, Democritus, and Epicurus. The theory of the "Vestiges" was nothing more than a restatement, in popular form, of that of Lamark, and there was no pretension that its author had contributed any thing to it of scientific importance. The real reason, undoubtedly, why the new statement was caught at with such avidity, was the growing conviction that the prevailing explanation of the origin of living forms, by special creation, was indefensible. The "Vestiges" was widely read, but the theory was not accepted, because it did not offer any rational or probable scientific solution of the difficulty. There was, however, a kind of indefinite feeling that the inquiry was in the true direction, and that its fundamental conception might be strengthened and verified by further investigation. This apprehension is well shown by the following extract from a letter of Principal James D. Forbes to Dr. Whewell, in 1846: "You have read, of course, the sequel to the 'Vestiges'.... the author of the 'Vestiges,' who is generally believed to be a denizen of modern Athens, has shown himself a very apt scholar, and has improved his knowledge and his arguments so much since his first edition, that his deformities no longer appear so disgusting. It was well that he began to write in the fullness of his ignorance and presumption, for, had he begun now, he would have been more dangerous." In 1859, Mr. Darwin and Mr. Wallace, working independently of each other, developed the principle of Natural Selection, which was the most important sin-

gle step that had yet been taken to account for the origin and diversities of living forms. That conception, which Professor Helmholtz pronounced "an essentially new creative idea," was soon generally recognized by philosophical naturalists as a valid principle, or natural law, and this gave a new aspect to the whole question. Dr. Hodge's statement, therefore, is one which an instructed scientific man would hardly venture to make.

THE EXPANSE OF HEAVEN. A Series of Essays on the Wonders of the Firmament. By R. A. PROCTOR, B. A. 305 pages. Price $2.00. D. Appleton & Co., New York.

AFTER a very successful lecturing tour in this country, in which he spoke nearly a hundred times, Mr. Proctor has gone back to England, but he has left us a legacy in the shape of a beautiful little book, "The Expanse of Heaven," which will enable us to go on with the subject, though the living teacher is absent. If Mr. Proctor is not a discoverer in astronomy, and even if he fails to take the highest rank as a lecturer, he is certainly a very able and attractive popular writer upon the subject. That he is thoroughly master of its modern questions there is no doubt, and he certainly possesses in a very marked degree the faculty of presenting them in a pleasing and instructive way. "The Expanse of Heaven" is his latest book, and we think is certain to be his most popular one. It deals with the larger views and grander themes of the science in a very easy and readable manner, and with many touches of poetic feeling that are kindled by the sublimities of the subject. A careful examination of the volume shows that it covers the ground very fully of his lectures in this country, but the statements are far more finished and perfect than any reports of oral discourses could possibly be. We heard his lecture upon the Nebular Hypothesis, but neither the delivery nor the printed sketch will bear comparison for a moment with the two papers in this volume entitled "How the Planets grew." Of the thirty topics considered in the book, and selected with reference to their general interest, "The Sun," "The Evening Star," "The Ring-girdled Planet," "Visitants from the Star Depths," "The Earth's Journey through Showers," "Worlds ruled by Colored Suns," "The Depths of Space," and "The Drifting Stars," are perhaps the most attractive, although different readers will have different opinions upon this point.

THE PHILOSOPHY OF HERBERT SPENCER: Being an Examination of the First Principles of his System. By B. P. BROWNE, A. B. 283 pages. Price, $1.25. New York: Nelson & Phillips.

THIS is a swaggering polemic, designed to be in the interests of religion, and written by a man equally and eminently self-conscious and unscrupulous. It will be regarded as a masterly reply to Mr. Spencer by those who know nothing of that thinker's doctrines, for, by the aid of misrepresentation and setting up men of straw, he achieves a succession of the most brilliant logical victories. In the last *Bibliotheca Sacra*, Prof. Mears, of Hamilton College, gives an article to the adverse criticism of Mr. Spencer; but of the man he says: "It is a long time since purely English philosophy has produced so able, so comprehensive, and so daring a thinker as Herbert Spencer." In his works "we have some of the clearest and most forcible statements of opinion upon great and abstract topics to be found in the English language. If the truth must have opponents, it is just such opponents we prefer to see and to meet—frank, outspoken, unreserved." This is the general judgment that is passed upon Mr. Spencer by eminent thinkers who have studied him, whether they agree with his views or not. But Mr. Browne is of a different opinion. His pages are filled with expressions of contempt, from which we gather that Mr. Spencer is such a transparent fool, and such an obvious knave, that his critic's task is a very light one; and we wonder that he condescended to bring his intellect down to such trifling work. Buffoonery, puerility, absurdity, thimble-rigging, jugglery, sleight-of-hand, are samples of the terms used to characterize Mr. Spencer's reasoning, while his philosophical method is said to be "a purely hap-hazard system," "a miracle of confusion and absurdity," which "takes an insane delight in knocking out its own brains." We observe that the theological press commends this book to its readers as putting an end to

Spencer. Can it be that they are really in such a desperate way in that camp?

ANNUAL RECORD OF SCIENCE AND INDUSTRY FOR 1873. Edited by SPENCER J. BAIRD. New York: Harper & Bros. 714 pp., 12mo. Price $2.00.

THIS volume presents a very large amount of valuable and interesting information in compact form, being in fact a history of progress in science and art for the year. The main part of the book is prefaced with a brief summary of the year's progress. The matter is presented in divisions named according to their nature, in general scientific terms, as Mathematics and Astronomy, Terrestrial Physics, and Meteorology, etc. Much important knowledge bearing directly on the ordinary affairs of life is to be gleaned from the divisions on Agriculture and Household Economy. For instance, the latter contains some valuable facts about lightning and lightning-conductors. Chimneys should be kept clean, as one lined with a thick layer of soot is dangerous, being apt to conduct the current of electricity into the house. The costly copper rods now so popular are condemned, and the ordinary galvanized iron wire, No. 4, recommended instead. A conductor, to be effective, should have no joints nor acute angles, and the lower end should rest in the ground, while the upper should be tipped with a gilded or polished point. Conductors are also likely to become impaired from use, and therefore need occasional examination and repairing. In the division of Materia Medica, a simple and effectual method is given for distinguishing real from apparent death. This is in simply tying a tight ligature around a finger of the supposed corpse; if death is only apparent, the end of the finger will shortly become red.

About meteors and comets, we are told, Prof. Proctor has concluded that comets are detached masses of matter thrown off by planets like Jupiter, Neptune, and Uranus, while in a molten condition. Meteors are fragmentary parts of disintegrated comets. The inflammatory character of meteors has also been established. In May, 1873, two men in North Germany observed a falling meteor strike against a church-tower, and rebound with loud detonation to a house-top. The house soon became enveloped in flames, which spread and destroyed several adjoining buildings. The most startling statement, probably, comes from Secchi, the great Italian astronomer. This is that the sun varies in size. Secchi's hypothesis is, that the sun's photosphere as seen by us is a gaseous envelope, continually, and perhaps periodically, changing in apparent size.

THE KINDERGARTEN MESSENGER. Edited by ELIZABETH P. PEABODY. Monthly, 24 pages, $1.00 per year. 19 Follen Street, Cambridge, Mass.

THE name of Froebel is becoming as familiar in connection with a method of child-culture called the Kindergarten, as was the name of Pestalozzi a few years ago in connection with the method of school instruction by objects. Froebel's course, like the college curriculum, runs through four years, from three to seven, of the child's life. His idea is not only to furnish objects so as to influence early impressions, but to combine action with observation, and make play-studies available in the first steps of education. Froebel, motherless from his earliest recollections, and then having the experience of a step-mother who neglected him, was drawn by a powerful sympathy to children, whom he thought are generally neglected, and was moved to do something to beautify and enrich their opening lives. That his devices were ingenious, and his own practice probably successful, may be freely admitted, and it must be acknowledged also that he dedicated himself to a noble work; but to what extent he struck the true principles of the management of children is not so clear. Certain it is that many of his followers made but sorry work in their endeavors to carry out his system. Long interested in this question of the first steps in education, and having heard much of Froebel's new dispensation, we sought out a Kindergarten school in London several years ago which was conducted by teachers trained at the feet of the master. The method was there in all its novelty, and it was obvious enough that it contained many excellent features; but, alas! the trail of the school-room was over them all. It had become a routine, and although marching, singing, and various activities, were a part of it, there was the same mechanical

listlessness with which we were familiar under the old ways. We do not generalize from this single instance, but we gather from an examination of Miss Peabody's tracts that there has been not a little rough and crude work in the attempt to carry out Froebel's plan. But the merit of this reformer is independent of the perfection of his method. He has done the world incalculable service by fixing its attention, first and clearly, upon a subject of the greatest importance, and the attempts to carry out his method can hardly fail to lead to something better. Miss Peabody is among the pioneers of the movement in this country, and she has worked like a saint in the cause. Her little periodical deserves to be liberally sustained. Kindergarten schools are springing up in various places, and their managers will need all the enlightenment they can get. But, whether schools be established or not, the literature of the subject abounds in valuable suggestions that may be made available in home education. For it is here after all that the main interest must centre, and to us the highest value of the movement is its possible result in giving us more competent and better-instructed mothers. We note not without apprehension the growing disposition to invoke State agency in the establishment of this new order of educational institutions. Should this plan succeed, and the new schools be, moreover, subjected to the principle of "compulsory education," as by the logic of the case they must, the situation will become interesting. To the extent in which the Kindergarten idea becomes the rival of family nurture and is resorted to by mothers to escape their responsibilities, it will be injurious; but, in so far as it has the contrary effect and educates mothers as well as children, it will prove a boon to society.

FIRST LESSONS IN THE PRINCIPLES OF COOKING. By Lady BARKER. London: Macmillan & Co. 101 pp., 18mo, price 50c.

THIS little book treats of the chemical composition of food; the effect on the human body of the different substances used as such; of the modes of preparing certain kinds of food in conformity with their action; and of the principles of diet. In the first part is shown what elements are necessary to make animal or vegetable substances fit for food, and what substances possess those elements in the highest degree. The second part explains easy and economical methods of making bread, cooking vegetables, meats, etc., and building and keeping up kitchen-fires. The third part enforces the truth that the body is benefited not by the quantity of food eaten, but by the quantity digested, and goes on to show what kinds of diet are best adapted to the digestive organs of persons in different occupations. The book contains much information that is valuable to the housekeeper.

FUEL. By C. WILLIAM SIEMENS, D. C. L., F. R. S., and JOHN WORMALD, C. E. New York: D. Van Nostrand. 81 pp., 18mo, price 50c.

THIS work comprises two addresses delivered before the Council of the British Association. The first part discusses the nature of fuel, the source whence it is derived, the best methods of using it economically, the coal question of the day, and solar heat. Fuel is defined as any substance capable of entering into combination with another substance and giving rise to heat in the act, and it is shown to be derived from solar energy acting upon the surface of our earth. The subject is handled in a scientific manner, and has a direct practical bearing on economy of the use of fuel in manufactures, transportation, and the household. The second part ostensibly compares the value of artificial fuels with coal, but is little more than an enumeration of the various attempts that have been made within the past hundred years to produce an artificial fuel.

WE are informed by the *Boston Globe* that the forthcoming work of Mr. John Fiske, to be simultaneously published in England and this country, is nearly completed, and will be issued early next autumn. Those who have been interested in his lectures will be gratified to learn that these are to be reproduced in a carefully-revised form, with much new matter which will give his work a comprehensive character It will be in two volumes, comprising nearly a thousand pages, under the title of "Outlines of Cosmic Philosophy based on the

Doctrine of Evolution." It is a much less exhaustive and more popular treatise than Mr. Herbert Spencer's yet unfinished "System of Synthetic Philosophy," upon which it is mainly founded; but it embraces a wider range of subjects than is discussed by Mr. Spencer. Those who are familiar with Mr. Fiske's remarkable powers of exposition and grasp of thought will need no assurance as to the interest of the work, and to others we may say that it will undoubtedly be the most valuable introduction to modern scientific philosophy that has been yet produced. Mr. Fiske is expected to return from Europe about the last of June.

A POPULAR KEY TO THE BIRDS, REPTILES, BATRACHIANS, AND FISHES OF THE NORTHERN UNITED STATES, EAST OF THE MISSISSIPPI RIVER. By Prof. DAVID S. JORDAN, M S., and BALFOUR H. VAN VLECK. Appleton, Wis. 108 pages. Price, 75 cents in paper covers; $1.25 in flexible cloth.

THIS is a convenient pocket manual, designed to enable collectors readily to ascertain the names of the birds, reptiles, and fishes, occurring in the region indicated.

PUBLICATIONS RECEIVED.

Diffractive Spectrum Photography. By Henry Draper, M. D. Pp. 9.

Notes on Microscopic Crystals, and Observations on Unionidæ. By Isaac Lea, LL. D. Pp. 24.

The Protoplasm Theory. By Edward Curtis, A. M., M. D. Pp. 23.

The Medical Colleges, the Medical Profession, and the Public. By Standford E. Chaillé, A. M., M. D. Pp. 24.

Materialism, its History and Influence on Society. By Dr. L. Büchner. New York: Asa K. Butts. Pp. 28.

The Essence of Religion. By Ludwig Feuerbach. New York: A. K. Butts. Pp. 75.

The Vermiculetes. By Josiah P. Cooke, Jr. Pp. 32.

Review of "Darwin on Expression." By Alexander Bain. London: Longmans, Green & Co. Pp. 18.

Transactions of the American Society of Civil Engineers. Pp. 50.

Seizing Books and Papers under the Revenue Laws. Published by the New York Chamber of Commerce. Pp. 56.

Report on the Incurable Insane in Illinois. By Fred. Wines. Pp. 11.

Community of Disease in Men and Other Animals. By W. Lauder Lindsay, M. D. Pp. 37.

Lecture on Buddhist Nihilism. By Max Müller. New York: A. K. Butts. Pp. 16.

Thirteenth Annual Report of the Brooklyn Park Commissioners. Pp. 47.

A Third Catalogue of Seventy-six New Double Stars. By S. W. Burnham, Esq. Pp. 14.

The Money Problem. By Henry Bronson. Pp. 28.

Bulletin of the Minnesota Academy of Natural Sciences. 1874. Pp. 150.

The Anatomical, Pathological, and Surgical Uses of Chloral. By W. W. Keen, M. D. Philadelphia: Lippincott, 1874. Pp. 19.

Epidemic Delusions. By Frederic R. Marvin, M. D. New York: Asa K. Butts. Pp. 28.

The Rules of Evidence, as applicable to the Credibility of History. By William Forsyth, Q. C., LL. D., M. P. London: Robert Hardwicke, 1874. Pp. 22.

Intellectual Culture. By Edward Palmer, M. D. Louisville, 1874. Pp. 20.

MISCELLANY.

A Science Minister for England.—There is an agitation now going on in England for the appointment of a responsible government minister, whose duty it shall be to look after the interests of science and scientific research and education, and to take charge of the scientific institutions of the country. A writer in the *Times*, Colonel Strange, whose views are approved by *Nature*, calls attention to the fact that, though "there is more individual enterprise in England than in any country in the world," yet the English are being rapidly outstripped by other nations. At present, the various

scientific institutions maintained by the state are under no less than seven different governmental departments, all of which have other matters besides science to attend to. The writer names six observatories, of which one, Greenwich, is under the Admiralty; another, Edinburgh, under the office of Works; a third, at the Cape of Good Hope, under the Colonial office; and the rest under the India office. The other departments of state which assume to direct scientific work are the Privy Council and Board of Works, and Board of Trade. Colonel Strange favors the creation of a Science Minister, under whose control all these scientific institutions shall be placed. "Let this be done," says he, "and we should cease to witness the farce of consulting the Chancellor of the Exchequer about observing eclipses of the sun, the prime-minister about scientific arctic expeditions, and the Treasury about tidal reductions. We should perhaps, too, then perceive that overworked law-officers are not the best managers of a great, or what should be a great, technical museum, and that fifty irresponsible gentlemen, however eminent individually, ought not to be intrusted with the grandest collection of art and natural history in the world."

The Acoustic Properties of the Atmosphere.—The coasts of the British Isles are exceedingly beset with fogs, which make navigation in their vicinity a very dangerous business. During a period of ten years these fogs were the cause of 273 shipwrecks, many of which were attended with serious loss of life. As signals in thick weather, lights are almost worthless; sounds have, accordingly, been substituted, and instruments for producing them, such as bells, fog-horns, steam-whistles, etc., have been set up and employed at numerous stations. But it has been observed that the distances at which these sounds could be heard were extremely variable; that while at one time they would give warning seven or eight miles away, at another they were inaudible at half the distance, and perhaps totally useless for the purpose intended.

The authorities last spring requested Prof. Tyndall to look into the matter, which he did, and, as is usual with him, when he undertakes an inquiry, with interesting and valuable results. Selecting the South Foreland Cliff, in the Straits of Dover, as the site of operations, he began a series of experiments to test the distances at which various sounds could be heard. The instruments used for producing the sounds were, trumpets sounded by air, whistles sounded by steam, the steam-siren, and cannon. The observations were continued at intervals from the 20th of May last to the 25th of November. At different times sounds of like intensity were heard at widely-varying distances. For example, a sound that at one time could be heard only two miles, could at another time be heard twelve miles. On one occasion the sound of the steam-siren was heard fifteen miles. On the morning of June 3d, the sky being of a stainless blue, and the sea calm, the sound of a cannon could not be heard beyond two miles, and a "mortar fired with a three-pound charge yielded only a faint thud; it was mere dumb-show on the Foreland." The air was optically clear, but opaque and impenetrable to sounds. On other occasions, during fog and driving rain, the sounds could be heard at various distances, as four, five, seven, and nine miles; and once, when the air was hazy, they were heard twelve and three-quarter miles. The inference is, that the transmission of sound through the atmosphere is not affected by fogs and rain; the air during their prevalence may be opaque to sound, but not on that account. The movement and arrest of sound in the air depend on other conditions than the mere presence of fog or rain, and these conditions may exist when the atmosphere is wonderfully clear to the eye. What, then, becomes of the enormous volumes of sound produced by cannon and the steam-siren, seeing that they are neither transmitted nor annihilated? In order to determine this question, Prof. Tyndall and his companions took a position on the shore overlooking the sea, and there for the first time demonstrated by experiment "the reflection of sound from aërial surfaces. From a perfectly clear air the sounds came back in echoes. They reached us as if by magic from absolutely invisible walls." Now, what are the conditions which thus intercept the sound-waves? The phenomenon is clearly

due to a non-homogeneous atmosphere produced by inequalities of temperature, and the unequal distribution of vapor. "As I stood upon the deck of the Irene," says Prof. Tyndall, "pondering the question, I became conscious of the exceeding power of the sun beating against my back and heating the objects near me. Beams of equal power were falling on the sea, and must have produced copious evaporation. That the vapor generated should so rise and mingle with the air as to form an absolutely homogeneous mixture, I considered in the highest degree improbable. It would be sure, I thought, to streak and mottle the atmosphere with spaces in which the air would be in different degrees saturated. . . . At the limiting surfaces of these spaces, though invisible, we should have the conditions necessary to the production of partial echoes and consequent waste of sound." This philosophical explanation Prof. Tyndall was able to verify. On one occasion, when the air was opaque to sound, a cloud arose and threw its shadow over the sea. Some increase in the intensity of the sounds was noticed; but, with decline of the sun, it was more obvious, until at length the signal-sounds were heard at a distance of twelve and three-quarter miles, when at first they were inaudible at two miles. The increase of distance at which the sounds were distinctly heard was gradual with decline of the sun, or, what is quite obvious, with increase of homogeneity of the atmosphere. This was fully shown on another occasion, when, during a violent rain, the transmission of sounds was greatly increased, so that they could be heard more distinctly at seven and one-half miles than at five miles previous to the storm.

The Anderson School at Penikese.—The Anderson School of Natural History will open this year on Tuesday, July 7th, and close on Saturday, August 29th. During the session, Prof. Mayer, of the Stevens Institute, Hoboken, will deliver a course of lectures on Physiological Physics. Mr. Theodore Lyman, of the Cambridge Museum of Comparative Zoology, will give a few lectures on Pisciculture. Lectures will also be delivered by Dr. W. S. Barnard, of Ithaca, N. Y., on Protozoa; Prof. Jordan, of Appleton, Wis., will take charge of the instruction in Marine Botany. Mr. Alexander Agassiz will have charge of the instruction on Radiates and Embryology; Dr. A. S. Packard, Jr., of Salem, Mass., on Articulates; Prof. B. G. Wilder, of Cornell, on Vertebrates; Prof. E. S. Morse, of Salem, and Prof. C. E. Hamlin, of the Museum of Comparative Zoology, on Mollusca; Mr. T. W. Putnam, Director of the Peabody Academy of Science, on Fishes; Mr. Edwin Bicknell, of the Museum of Comparative Zoology, on Microscopy. Instruction in Drawing will be given by Mr. P. Roetter, of the Museum of Comparative Zoology. Dr. Packard and Mr. S. W. Garmon will take charge of the dredging expedition, and the laboratories will also be under the supervision of Mr. Garmon.

Scientific Apparatus. — While it cannot be questioned that the popular demand in this country for appliances with which to illustrate the first principles of physical science is well met by several makers of philosophical instruments in this and other cities, it is still true that, in the higher branches and grades of scientific illustration, our chief dependence for efficient apparatus is upon English, French, and German makers. In the two great departments of Electrics and Optics this is especially observed, and we take pleasure in commending to the notice of professors and teachers of science the card of Mr. Browning, of London, in our advertising page this month. Mr. Browning is an honored Fellow of the Royal Astronomical Society of England, and, what is more to the present purpose, he is the successful maker to the Royal Society, and to the leading English observatories, of the instruments they employ in their great and varied work. In the construction of spectroscopes of every sort he has, perhaps, no equal, certainly no superior.

Soaring and Sailing of Birds. — Mr. Belt, describing the movement of a pair of black vultures sailing on the wind, says: "Like all birds that soar, both over sea and land, when it is calm the vultures are obliged to flap their wings when they fly; but when a breeze is blowing they are

able to use their specific gravity as a fulcrum, by means of which they present their bodies and outstretched wings and tails at various angles to the wind, and literally sail. How often when becalmed on southern seas, when not a breath of air was stirring, have I seen the albatross, the petrel, and the Cape-pigeon, resting on the water, or rising with difficulty, and only by the constant action of their long wings able to fly at all! But when a breeze sprang up they were all life and motion, wheeling in graceful circles, now presenting one side, now the other to view, descending rapidly with the wind, and so gaining velocity to turn and rise up again against it. Then, as the breeze freshened to a gale, the petrels darted about .... poising themselves upon the wind with as little effort as a man balances himself upon his feet."

An Aged Pelican.—*Land and Water* contains an interesting "obituary notice" of Jack the Pelican, for upward of forty years an inhabitant of the Dublin Zoological Gardens. This fine specimen of the genus *Anser* was presented to the gardens in 1831, being then full grown, and supposed to be seven or eight years old. Jack was generally about the first specimen which was introduced, or rather introduced himself, to the notice of visitors, as he was seldom shut up in a cage, but walked or waddled about where he pleased. He usually treated strangers with sovereign contempt, hardly deigning to get out of their road; but when seized, and his beak opened to show his curious little cleft tongue, which lay at the bottom of the pouch, under the bill, his eye, usually a splendid ruby, or rather carbuncle color, got red as a coal, with anger, at the indignity. His plumage was always in the most beautiful order and the most brilliant white, except about the head, where the soft, downy hackles assumed a pinky hue. Curiously enough, he never went into the water, except occasionally for the purposes of ablution, when he would duck and wash himself all over; then, returning to land, squeeze the water out of his feathers with his bill, and stand in the sun to dry. But he never seemed to swim for pleasure or to fish, in which respect he differed from the three junior members of his tribe, also locked up in the gardens. Another peculiarity of his was that he would never touch any food but fish. The others soon learned to eat and relish horse-flesh on occasion, but Jack stood out stanchly, and fish, and fish only, he would have, at whatever cost, all attempts at deceiving him being in vain. Jack knew his friends and enemies well, and when he first came, and until the death of his original owner, a Mr. Egan, it was absurd to see the way he attached himself to that gentleman, running to meet him at the gate, and never leaving his side. For some time before his death he subsisted on a stimulating diet of live eels and whiskey-punch.

Species of Dicotyledonous Plants.—The number of that great section of flowering plants which, when the seed sprouts, give off two ledons, or embryonal leaves, is shown in the "Prodromus" of De Candolle, recently finished in seventeen volumes, to be very large. Not counting the eminent men that have given earnest work on it as specialists, it has had the conduct of three generations of De Candolles, the grandfather, Augustin, who dying bequeathed it to his son Alphonse, who in like manner left it to his son Casimir. The first and the second wrought together for years, as did also the second and the third. The work describes 5,134 genera and 58,975 species, which is probably not more than one-half the number of species of dicotyledonous plants existing. The principal natural orders described are:

	Genera.	Species.
Compositæ	911	8,561
Leguminosæ	283	3,858
Rubiaceæ	225	1,888
Euphorbiaceæ	191	3,272
Scrophulariaceæ	176	1,879
Umbelliferæ	160	1,016
Acanthaceæ	154	1,481
Asclepiadaceæ	134	1,013
Labiatæ	122	2,401
Cruciferæ	100	988
Solanaceæ	65	1,725

The most numerous genera are as follows:

	Species.
Solanum	915
Euphorbia	751
Senecio	601
Croton	461
Phyllanthus	447
Erica	429
Salvia	410
Peperomia	389

The Pneumatic Dispatch.—The following description of the London "Pneumatic Dispatch," for the conveyance of small parcels of goods from place to place, we take from the *Times:*

"The pneumatic tube extends from the London and Northwestern Railway Station at Euston Square, to the General Post-Office in St. Martin's-le-Grand. The central station is in Holborn, where is also the machinery for effecting the transit of the trains. Here the tube is divided, so that in effect there are two tubes opening into the station, one from Euston to Holborn, and the other from the Post-Office. The length of the tube between Holborn and Euston is exactly a mile and three-quarters. The tube is of a flattened, horseshoe section, 5 feet wide and 4 feet 6 inches high at the centre, having a sectional area of 17 square feet. The straight portions of the line are formed of a continuous cast-iron tube, the curved lengths being constructed in brick-work, with a facing of cement. The gradients are easy; the two chief are 1 in 45 and 1 in 60; the sharpest curve is that near the Holborn station, which is 70 feet radius. The tube between Holborn and the Post-Office is 1,658 yards in length, and is of the same section, and similarly constructed to the first length. Two gradients of 1 in 15 occur on the Post-Office section, but this steep inclination is in no way inimical to the working of the system. The Holborn station is situated at right angles to the line of the tubes, which are therefore turned toward the station into which each opens. All through-trains, therefore, have to reverse there, and this is effected in a simple manner by a self-acting arrangement.

"The wagons, or carriers, as they are termed, weigh 22 cwt., are 10 feet 4 inches in length, and have a transverse contour conforming to that of the tube. They are, however, of a slightly smaller area than the tube itself, the difference—about an inch all round—being occupied by a flange of India-rubber, which causes the carrier to fit the tube exactly, and so to form a piston upon which the air acts. The machinery for propelling the carriers consists of a steam-engine having a pair of 24-inch cylinders with 20-inch stroke. This engine drives a fan 22 feet 6 inches in diameter, and the two are geared together in such a manner that one revolution of the former gives two of latter. The trains are drawn from Euston and the Post-Office by exhaustion, and are propelled to those points by pressure. The working of the fan, however, is not reversed to suit these constantly-varying conditions; it works continuously, the alternate action of pressure and exhaustion being governed by valves."

NOTES.

Dr. James McNaughton, President of the Albany Medical College, and Professor of the Practice of Medicine, is supposed to be the oldest medical lecturer now in active service. He has delivered fifty-three annual courses of lectures, and, during this half-century of work, has not missed a dozen lectures or been confined to the house a week by sickness. He is seventy-seven years old, and is hale and active.

The white-willow, it is said, has been used very successfully in Iowa for fencing. C. B. Mendenhall, of Marshall County, has about thirteen miles of white-willow fence, of from three to seven years' growth, of which above half will turn cattle. He has also a grove of white-willows, set out about six years ago, which is considered to be worth about $500 per acre.

A Western paper reports that a spaniel, named Curly, performs the duties of mail-carrier between Lake of the Woods, Dakota, and the Minnesota line, twelve miles distant. Letters and papers are placed in a sack and tied about the dog's neck; he is told to go, and never fails to reach his destination. On his arrival, the mail is overhauled, the dog is treated to a good dinner, and started back again.

Philadelphia possesses a very energetic Zoological Society of about 500 members. Thirty-five acres of ground in Fairmount Park have been assigned to them for a zoological garden, though for the present they will occupy but ten acres. Within the last six months the society has laid vulcanite walks through the garden, built a monkey-house, and made other provision for a large number of beasts and birds from all parts of the world. A small collection has already been made, which will this summer be added to by importations from Africa, Asia, and Australia. There will be a large aquarium, and it is intended to institute courses of popular lectures on Natural History.

At a meeting of the Philadelphia Academy of Sciences, Mr. Meehan exhibited a

small Norway spruce, the branches and leaves of which were of a golden tint. He said that, when plants had little food, or lost their fibres in wet soil, and thus could not not make use of food, the yellow tint was generally seen in their leaves. Judging that something analogous must have happened to the spruce, he, on examination, found its roots thickly enveloped by the mycelia of a fungus, which destroyed the young rootlets as fast as they were developed. Only a few trees in his grounds had been attacked two years ago; but during the past two seasons the fungus had spread underground from plant to plant, till now there were over one hundred diseased. He had supposed the fungus to be of the microscopic kind; but in October last the mycelia developed into a brown *agaric* with a pileus about two inches broad, but the exact species of which he could not determine. He suggested that, as the phenomena in the case of what is known as "peach-yellows" were of the same nature, those who had the opportunity to examine might find the roots attacked by a fungus in the same way.

It is stated in the Cincinnati *Gazette* that Mr. S. A. Bell, of Plainfield, Ohio, has found under an ancient mound a quantity of fragments of bones of very young children, with the tooth of a rodent animal, which had been used as a neck ornament. These relics were discovered in a large bed of coal and ashes, indicating that the fire had covered a space of twenty-five feet in diameter. It is supposed that the children were the victims of some bloody sacrificial rite. The mound under which the relics were buried was of medium size, and its materials had been transported from a considerable distance, and from several different points.

It is universally admitted that asphalt makes a perfect pavement in all respects, except that it is very slippery under certain conditions, that is, when covered with mud. Hence, if an economical method of keeping the surface clean can be devised, this kind of pavement is to be preferred to all others. Impressed with this belief, the London Commissioners of Sewers have directed experiments to be made as to the best mode of cleansing, and the several asphalt companies have united in offering a premium for any improved plan of effecting this purpose.

Analysis of asparagus-shoots, by A. Vogel, shows that the extremities contain no sugar, though the stem, three or four inches below, contains 1.7 to 2 per cent. The explanation is, that the sugar is used up in the formation of cells, which goes on actively in the shoots. The same is the case with potato-shoots.

Absolutely pure iron is said to have been produced by a Russian chemist, by means of the galvanic battery. During the process, a large quantity of hydrogen was disengaged from the ordinary iron used. The pure iron is a silver-white metal, very malleable and ductile, and so soft as to be readily cut with a pair of scissors. It is very different from iron which has hitherto been supposed to be pure. It oxidizes very rapidly, and water is decomposed by it by the rapid absorption of oxygen.

It is proposed to apply the sand-blast to the quarrying of slate, either for slabs or roofing-slates, thus preventing much of the waste inevitable under the present imperfect methods of quarrying. As this waste frequently amounts in weight to as much as nine times the weight of the marketable article produced, it will be seen that there is a wide margin for the profitable use of this invention. The process is also applicable to quarrying stone, and for cutting hard rocks in railroad tunneling.

The "quick-signal railroad lantern" is a very useful contrivance, and destined to supersede the common lantern on all railroads. This lantern is furnished with a mechanism whereby in the fraction of a second a white light may be changed to ruby, and *vice versa*. This is effected by means of a small inverted cup of ruby glass which surrounds the flame, having of course an opening above for the escape of smoke. The cup may be depressed beneath the flame, and then the lantern gives a white light; or it may inclose the flame, and then the light is red.

Harness and other articles of leather which are injuriously acted upon by the ammoniacal exhalations common in stables may, according to Prof. Artus, be thoroughly and effectually protected by the addition of a little glycerine to the oil or blacking with which their surfaces are treated.

Iron is not volatile, except at very high temperatures, like gold and platinum. Dr. Elsner, director of the Berlin Porcelain-Works, has tried the experiment of subjecting a small piece of iron, in an unglazed crucible, to a long-continued exposure to a temperature of over 3,000 Cent., when he was distictly enabled to recognize minute needles of crystallized iron on the cover of the crucible, the result of vaporization.

Cut flowers may be kept fresh for a fortnight, it is said, by dissolving sal-ammoniac or chlorhydrate of ammonia with the water in which the stems are put, in the proportion of about 75 grains per quart of water. The experiment is one which can be easily made.

Dr. THOMAS YOUNG.